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PREFACE

The authors of chapters in this volume of the *Annual Review of Psychology* were requested to select the areas of significant change and advance within their fields and then to prepare penetrating evaluations of recent research. Considering the large scope of their tasks and the limitations of time and of pages imposed upon them, we feel that they have carried out their assignments with remarkable success. Not only does the number of articles in each field increase every year, but the levels of technical and conceptual refinement in most fields are becoming steadily more sophisticated, so that the reviewer's task becomes ever more demanding.

Because of the necessity for selectivity of coverage, a reader may feel that in any one volume a particular field is slighted, or that the evaluations are incomplete or biased. But we hope over succeeding volumes to represent all major fields, advances, and points of view in psychology. The Editorial Committee and the editors welcome comments from readers on coverage and treatment. Such communications are discussed at our annual meetings when topics and panels of prospective authors are established for future volumes.

At present most chapters cover a fairly broad scope, are about 25 to 30 pages long, and appear more than 2 years after the authors accept their assignments. As a special innovation, we are planning to commission shorter articles on restricted topics to appear relatively quickly. Readers are encouraged to nominate topics that warrant such treatment. (It should be pointed out, however, that the *Annual Reviews* do not accept unsolicited chapters.)

The close of 1972 brought to an end the 5-year term of Professor Gardner Lindzey on the Editorial Committee. Throughout his tenure he has contributed to the work of the committee with sagacity and enthusiasm, even during the last year when he was occupied with the transition from one major departmental chairmanship to another. Harold H. Kelley has accepted the Board's invitation to fill this position for the next 5-year period. We also wish to express warm appreciation to Miss Jean Heavener, assistant editor, who is our full collaborator in the preparation of these volumes. Mrs. Dorothy Read prepared the accurate and detailed subject index.

M.R.R.
P.H.M.

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VOLUME 25 (1974)

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DEVELOPMENTAL PSYCHOLOGY

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The preparation of a chapter on Developmental Psychology for the *Annual Review of Psychology* is a devastating experience. The amount of material distributed among scores of journals and books cannot possibly be treated in a comprehensive manner. There appears to be no area of psychology that does not receive some attention from researchers with developmental interests. The selection of areas to be covered and the selection of particular works within the areas to be reviewed is extremely difficult. We have attempted to review areas in which there is a considerable degree of interest—or a need for more systematic attention. We have also tried to select a spectrum of articles for review in each area so that readers may derive some sense of the overall quality of the work being conducted.

INFANCY

Interest in infant behavior continued to boom in the past year with the publication of approximately 70 selections devoted solely to the topic. Contrary to White's (237) expectations, the use of newborns as subjects for research is not approaching that of the white rat or college sophomore. Of the publications reviewed for this article only 10% used newborns as subjects. The modal age of subjects was between 3 and 8 months. Data on the 24- through 36-month age range, however, remained scarce.

State.—Physiological state continued to be a topic of considerable interest in infant behavior. State has been shown to be a determinant of infants' responses to a variety of stimuli. Ashton (7), for example, found that newborns (3–5 days in age) demonstrated differential responding to auditory stimuli of different frequencies only in quiet sleep. During other states differential responses were not obtained. Lamper & Eisdorfer (121) investigated the effects of state as a function of stimulus modality and found state affected responding to auditory stimuli but not to tactile stimuli, cold, and touch. The authors concluded that cold and touch were compelling stimuli and, therefore, overrode the effects of state.

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[1] The contributions of the two authors to this review were equal. We wish to express our gratitude to Richard Olson for his contributions to the section on perception and to Marcia Rosser for her aid in assembling the materials for the review and for her work in preparing the manuscript.

A number of investigators, including Ashton (6, 7), Giacoman (57), Brackbill (17, 18), and Lamper & Eisdorfer (121), reported that presentation of intense stimuli to infants in an aroused state such as active alert or crying quiets both newborns and older infants (57). Brackbill & Ashton suggested that the quieting is a result of a CNS mechanism which acts as a stimulus overload control, allowing the infant to escape from too much stimulation by moving to a quieter state, usually sleep. Van den Daele (226), in a study of this effect with twins, suggested that the mechanism is genetically determined. Giacoman (57) reported that the effects of swaddling for 6-month-old infants (external stimulation) are dependent on the internal state of the infant such that hungry infants go to sleep with swaddling and satiated infants remain in the active alert state. Thus the analysis of the effects of intensive stimulation on state must be evaluated with respect to interoceptive as well as proprioceptive stimuli.

Brackbill (17, 18) hypothesized from data collected on an anencephalic infant that the protective mechanism is of subcortical origin. Jackson et al (96) suggested that the CNS protective mechanism has important consequences for learning and perception research with newborns. On the basis of heart rate data these authors suggested that the presence of a protective energizing arousal system and the relative inaccesibility of an orienting arousal system limit the learning capacities of the newborn.

The significance of state for infant research has been aptly demonstrated. However, Lewis & Johnson (126) argued that controlling the effects of state by rejecting subjects at the time of testing because they are in an inappropriate state may distort the data picture obtained. These authors suggested that there are qualitative differences in the behavior of infants rejected and selected on the basis of state. It may be that selection on the basis of state includes a number of as yet undefined variables which influence infant behavior.

In light of Bower's (15) recent work, in which he argued that most studies of infant behavior underestimate the infant's capacities because of confounds due to state, the importance of systematic evaluation of state variables cannot be understated. If, in fact, supine infants are never fully awake and alert, as Bower and Prechtl (171) suggested, much of the current work on infants underestimates the capacities and abilities of infants.

Physiological: Measures of attention.—The investigation of physiological correlates of attention or orienting behavior in infants has focused primarily on changes in cardiac activity. For adults a decrease in beats per minute (cardiac deceleration) at stimulus onset is correlated with attention or orienting to the stimulus; an increase in beats per minute with stimulus onset (cardiac acceleration) is correlated with startle responses. For infants the relationship of cardiac changes to stimulus presentation appears to be a complex function of state, stimulus parameters, and age. Berg, Berg & Graham (12) reported that newborns and adult subjects show less cardiac orienting behavior than infants 4–6 months of age. These age-related differences appeared to be independent of initial heart rate level and of differences in the functional relationships with state and stimulus characteristics. Jackson et al (96) reported that newborn infants failed to reliably demonstrate cardiac orienting to auditory stimuli in all states except the active alert state where a slight trend toward cardiac deceleration was found.

Berg et al found that the cardiac response to auditory stimuli presented to 4-month infants in nonalert states was dependent on stimulus onset parameters; rapid stimulus onset (short rise time) produced accelerative cardiac responses whereas slow stimulus onset (long rise time) produced deceleration. For infants in alert states stimulus onset was not effective in producing cardiac changes but rather intensity appeared to be the critical variable. Four-month-old infants in awake states demonstrated cardiac deceleration with the magnitude of deceleration being a function of stimulus intensity.

Lewis (125) reported that 3-, 6-, and 12-month-old infants in an awake state displayed cardiac deceleration to both stimulus onset and offset. Lewis argued that deceleration to stimulus onset reflects cognitive activity and that deceleration to stimulus offset is a simple function of energy changes in the surround.

The parameters and their interactive qualities involved in cardiac responses appear to be in an early stage of investigation. Thus, heart rate measures are not available as a general tool for investigating infant orienting behavior. A number of reviews concerning the use of cardiac measures may contribute to the generality and usefulness of the measure (cf 159, 243).

Perceptual and cognitive development.—A consistent sequence of changes in infant perceptual behavior has been reported by a number of authors. The general sequence is as follows: infants less than 6 weeks of age do not display reliable preference behavior to either familiar or novel stimuli; between 6 and 8 weeks of age a reliable preference for familiar over novel stimuli is obtained; by 8–11 weeks of age infants consistently prefer novel to familiar stimuli (47, 186, 235, 237).

White (237) suggested that at least part of the changes in behavior are due to maturation of the visual system and that prior to 6 weeks of age infants are not capable of any but the most primitive visual functions and do not often engage in visual inquiry due to the immaturity of the visual system. Fagen et al (47) offered support for the maturational hypothesis with a comparison of pre- vs full-term infants. Fagen et al found that full-term infants displayed a reliable preference for novel as compared to familiar stimuli between 10 and 11 weeks, whereas preterm infants did not display this preference until a full 4 weeks later. If, however, the infants were matched on conceptual age (date of last menstrual period), all subjects demonstrated reliable novelty preference at about 51 weeks of conceptual age. Fagen et al concluded that the "extra" experience that preterm infants had did not affect preference behavior, and supported a maturational hypothesis of age-related changes in visual behavior.

The shift in preference from familiar to novel stimuli has been interpreted by Weizman et al (235) and by Kagan (104) as the consequence of schema formation. That is, a precondition for attending to novelty in the schema model would be the formation of schemas as a result of attention to familiar stimuli. Once the schemas have been formed, the infant will attend to stimuli discrepant from his existing schema. Sameroff (187) presented a somewhat similar view of infant attentional and integrative functions based on schemata at three levels of organization. Thus, in Sameroff's view, before an infant can be conditioned he must first differentiate the schema system related to the response system, the schema system to deal with new or novel information, and, finally, a system which allows a relationship between perceptual and response systems to form.

Bower (15) has taken the extreme nativist position by hypothesizing the availability of complex perceptual and motor abilities in the newborn infant. Bower not only held that the infant has wired-in perceptual and motor abilities, but he also hypothesized that through perceptual input the infant is able to anticipate tactile consequences of motoric behavior. These data, however, need to be replicated with a careful consideration of state, especially in light of the data presented by White (237) and Kravitz & Boehm (120) suggesting that the behavior reported by Bower is not within the newborn's abilities.

By far the majority of data have been on the visual perception of infants 3 to 8 months of age. It is encouraging to report that studies of infant perception have begun to progress beyond the demonstration phase and that a few researchers have begun to probe the nature and quality of infants' perceptual experiences and memory for these experiences. The habituation paradigm has been used by a number of researchers to test both the nature of perceptual experience through generalization tests and the memorial functions of infants by manipulating the delay between familiarization and test (cf Jeffrey & Cohen 98).

Fagan (46) investigated memory in 5-month-old infants and presented them with familiarization training to 3 stimulus items. He tested habituation effects immediately and after varying delays. The familiar stimuli were paired with novel items for the habituation test either immediately or after a 4 or 7 minute delay. In all cases the novel items were preferred over the familiar stimuli. Fagen concluded that the infants demonstrated recognition memory for the familiar stimulus items. Fagen's results indicated that the memory span of 5-month infants must be at least 7 minutes.

Cohen et al (35) examined the nature of infant perception by testing the generalization of habituation to single attributes of a compound stimulus. Cohen et al found that changes in one dimension, either color or form, produced less response recovery than changes in both dimensions. Caron et al (32) found a similar generalization function in 3½-month-old infants with a conditioning procedure in which visual feedback (reinforcement) was contingent on head turning. The feedback either varied or was redundant across trials. Repetition of the same visual reinforcers produced a significant decrement in the rate of responding, whereas varied feedback maintained responding. Changes in the color of the stimuli were less effective than changes in pattern or changes in both dimensions for maintaining responding. The authors concluded that pattern is a more salient dimension for infants than color.

Contrary to the habituation literature, Caron et al reported that complexity of the feedback stimuli did not affect the repetition decrement in responding;

both simple and complex stimuli produced similar response decrements across repetitions.

McKenzie & Day (140) compared the use of the fixation preference introduced by Fantz as well as conditioning procedures as measures for generalization of orientation discrimination. The authors reported that during original learning for infants 7–12 weeks of age fixation times were related to complexity of the stimulus items but not to orientation of lines. The conditioning group was able to acquire consistent discrimination between vertical vs horizontal lines. Subsequent generalization testing indicated that the discrimination generalized to other vertical vs horizontal discriminations. The authors concluded that the use of fixation time was not as sensitive a measure of infant discrimination ability as conditioning precedures.

A consistent finding in the habituation literature was that females and males differed in terms of habituation rates (32, 35, 76). Jeffrey & Cohen (98) and Weizmann et al (235) reported that habituation rates were dependent on the familiarity of the testing situation. Females, if tested in a novel surround, demonstrated habituation, but if tested in a familiar surround, did not. Males, on the other hand, habituated if tested in a familiar surround and failed to do so when tested in a novel surround.

Recent work by Bower (15), Bower et al (16), and Nelson (157) suggested that object perception for 3- to 5-month-old infants is related to the motion of the object. Nelson (157) found that with training 5-month-old infants were able to anticipate the movement of an object hidden from view but that the training failed to generalize when the direction of motion was changed. Bower and his colleagues reported similar findings in that infants responded differentially to the same objects depending upon whether they were moving or fixed. Bower (15) interpreted the findings as indicating that motion defines the object such that an object in motion is not perceived as the same object standing still. These findings are consistent with those of the generalization testing reported above in that infants appear to be attending to the whole array of Gestalt and not selectively attending to one or more aspects of the array. Similar conclusions have been reached in studies of object permanence in that an object does not appear to be separated from its physical location by 8- to 10-month-old infants (73, 122).

Gratch & Landers (73) reported an interesting finding concerning the role of touch in infant perception. In one condition the infant was allowed to grasp an object, the infant's hand containing the object was then covered by a cloth. A majority of infants failed to retrieve or uncover their hand. The authors concluded that the infants were unable to recognize the presence of the object through touch. White (237) reported similar findings in that when an object was placed in the infant's hand outside the visual field the infant brought it immediately into the visual field. Gratch & Landers (73) suggested that it was as if the infants knew something was there but had to look to see what it was. Bower (15) has taken a similar position suggesting that vision, not touch, provides information for the infant.

Language.—Eimas et al (44), working with 2-month-old infants, and Moffitt (154), using 6-month-old infants, found that infants were capable of discriminating speech sounds along the voicing continuum in a manner approximating categorical perception. The authors concluded that these findings were consistent with the Chomsky-Lenneberg hypotheses of genetically coded language processes. That is, the mechanisms for categorical perception of speech are part of the biological makeup of the organism and are operative at a very early age.

Conditioning.—Two attempts were made to answer Marquis' question: "Can conditioned responses be established in the newborn infant?" Sameroff (187), in a review of the conditioning literature for 3- to 10-day-old infants, concluded that the occurrence of conditioning is dependent on the development of sensory and motor schemas. Before an infant can be conditioned, the sensory and motor schemas must be differentiated and the separate systems must be integrated, thus allowing the connections between stimulus and response to be formed. Sameroff's hypothesis was similar to Kessen's (113) description of organized patterns of behavior. Sameroff's hypothesis was that conditioning can strengthen or alter differentiated schema systems but cannot produce relationships for which the appropriate schemas have not been differentiated.

Fitzgerald & Porges (49) and Fitzgerald & Brackbill (48) also attempted to answer Marquis' question, but argued from a physiological rather than from a cognitive position. These authors asserted that success or failure to obtain conditioning in infants was the result of the maturational status of the nervous system. Conditioning is dependent on the differential rates of maturation of the cerebral structures which serve as the cerebral portions of conditioned reflex arcs.

Thus the answer to Marquis' question in 1971 was a qualified yes. Conditioning is dependent on the existence of organized systems mediating both sensory input and behavioral output. The systems have been conceived as either cognitive schemas (187) or cerebral structures (48).

Aside from the theoretical papers (48, 49, 187), the study of infant conditionability for its own sake has all but disappeared. The conditionability of infant vocalizations (141, 173) and classical conditioning of eyeblink responses to tactile stimuli (48) were demonstrated. Ramey & Ouith (173) found that conditioning failed to occur with delays of reinforcement of 3 or 6 seconds.

Conditioning procedures have been used with greater frequency to examine infant perceptual and memorial abilities and capacities (cf 32, 75, 139, 140).

Early experience.—Owing to the relative failure of intervention programs directed at preschool children, interest has shifted to infancy as the crucial period for introducing remediation measures (209, 232). On the basis of a deprivation model it was thought that enrichment of the infants' environment was the necessary means of remediation (232). White (237), Greenberg (75), Wachs & Cucinotta (228), and Watson (232), however, have found that a variety of enrichment precedures designed to enhance and accelerate cognitive-perceptual development produced at best little or no acceleration and, in some cases, led to retarded development in relation to untreated controls.

Two hypotheses concerning compensatory measures emerged from these failures. The first was that if an enrichment or training procedure was to be effective, periodic repetitions or partial repetitions of the procedures would be necessary to maintain the effects over time. Starr (209) evaluated the effectiveness of a variety of remediation programs and found that the programs producing the largest and most durable gains were those in which the initial training or enrichment procedures were repeated across time, either through parent training programs or organized reinstatement procedures.

Hunt (93, 94) offered the alternate hypothesis of "match," the idea that certain types of experience or encounters with certain kinds of circumstances will foster development only when a child has already acquired the necessary abilities, information, and learning sets to take advantage of the experience. Wachs et al (230) hypothesized that early overstimulation may be as disruptive as deprivation. In an extensive study of development from 7–22 months in lower and middle class infants, they found significant negative correlations between the level of ambient noise (TV, radio, talking), activity level of the home, and performance on a variety of Piagetian tasks. In addition, ambient noise in high amounts was negatively correlated with language development. Wachs et al concluded that, as a consequence of overstimulation, the infants habituated orienting and attentional responses to language.

Watson (232) added a dimension to Hunt's hypothesis by suggesting that it may not be overstimulation per se but *noncontingent* stimulation which may be the critical variable. Watson presented two groups of 2-month-old infants with an automated mobile for 10 minutes a day for 14 days. For one group motion of the mobile was contingent on a head-turn response and for the other group motion was noncontingent. A control group viewed the mobile for a comparable amount of time in a stationary position. When tested immediately and 6 weeks later (with no intervening experience with the mobile) infants in the noncontingent group failed to learn to control motion of the mobile on both tests.

The reviews and work cited above lead to the note of caution expressed by Watson concerning tutorial programs in infancy. Before it is possible to design and implement remediation and/or acceleration procedures, a sound base of information concerning infant functioning and cognitive-perceptual development during infancy is mandatory (232, 237).

BIOBEHAVIORAL RELATIONSHIPS

A sizeable proportion of the studies designed to investigate biobehavioral relationships are conducted with children who have been diagnosed as suffering from psychiatric or behavioral disorders. These reports must be treated with caution since frequently there is a discrepancy in the elegance of data collection between the biological and behavioral domains. Another overriding problem is the homogeneity of the sample which becomes the object of study. Varieties of etiology may produce comparable presenting symptoms. For example, hyperactivity or behavior designated as schizophrenic may be symptomatic of widely divergent biologic and/or experiential factors. The expectation that a particular treatment should produce comparable outcomes in subjects assigned to groups by present diagnostic procedures is far-fetched, particularly so when there is the additional confusion of including children within a wide age range. In the same vein, it seems unlikely that correlative outcomes between biological and behavioral measures will be any more robust than treatment effects unless the samples being dealt with represent extreme pathology. In that case children are so badly damaged that virtually all measures, biological and behavioral, are likely to reveal marked deficits.

Drugs.—Claghorn et al (34) tested the effects of acetazolamide on 23 retarded children between the ages of 3 and 14 who were classified as hyperactive. Acetazolamide was more effective in reducing restlessness and hyperactivity over a wide range of behaviors than either no treatment, placebo, or amphetamines. Acetazolamide is known to produce a variety of effects in cerebrospinal fluid so that particular mechanisms implicated in hyperactivity could not be specified in this study.

Campbell et al (29) tested the effects of methylphenidate on the behavior of hyperactive children on reflection-impulsivity, field dependence-independence, constricted-flexible, and automatized tasks. Their behavior was compared with a group of normal controls as well as with themselves under no treatment, drug, and placebo conditions. The guiding thesis was that the drug would affect the child's style of coping with cognitive tasks rather than any specific behavioral mechanism. As expected, under the no-treatment condition hyperactive children were more impulsive, field dependent, etc. When treated with the drug, they showed improvement in some of the tasks but no significant change in other tasks. The authors claim that under drug treatment there was a change in cognitive style which materially affected attention, impulse control, and response organization. The conclusion seems somewhat overdrawn since there was no significant advantage for the drug treatment over placebo in five of the eight measures. Furthermore, although mean reaction time scores in the reflection-impulsivity test doubled in the drug treatment as compared with the placebo condition, the standard deviation increased almost sixfold, raising questions about statistical as well as behavioral interpretations.

Methylphenidate was also employed by Greenwold & Jones (77) in a double blind procedure with three children whose classroom behavior was disruptive. They reported desirable effects on the behavior of their three subjects.

Eisenberg (45), in a thoughtful article, has discussed pharmacological, social, and ethical issues in the use of drugs to control the behavior of children. He has dealt with questions of developmental differences in vulnerability to drugs, and to long-term effects of drugs, as well as the question of how a child comes to be selected for drug treatment.

Pregnancy, birth, and later behavior.—Rutt & Offord (183) compared 33 schizophrenic children with their normal sibs on histories of prenatal and perinatal disorders. There were no significant differences between the groups on prenatal complications; however, the schizophrenic children had a significantly higher rate of perinatal disorders. At least ten perinatal disorders were included but there was no breakdown of frequency per child. In a comparable study of children classified as disturbed or psychotic, no relationship was found between type of current behavior and pregnancy and birth complications (143). McNeil et al (142) have studied the relationship between season of birth, season of conception, and emotional disturbance in children. They concluded that season of conception was related to increases in severe emotional disorders but not to milder disorders.

Other measures.—Surwillo (215) obtained reaction time measures on 110 normal boys aged 46–207 months. The object of the investigation was to determine if speed of reaction time was related to developmental changes in EEG. While high negative correlations were found between age and speed of reaction, it was concluded that developmental changes in EEG period could account for only a small fraction of these high correlations.

In an investigation of hyperkinetic (minimal brain dysfunction) and normal children with normal IQs, Satterfield & Dawson (189) hypothesized that the hyperkinetic children would have higher levels of basal skin conductance, a significantly greater frequency and magnitude of spontaneous nonspecific GSRs, and significantly greater GSR responsivity to novel stimuli. Contrary to expectations, the normal children significantly exceeded the hyperkinetic children on all three measures. An attempt to account for the outcome was made in terms of processes in the reticular activating system. Another attempt to distinguish children classified as suffering from minimal brain dysfunction from normal controls was carried out by Wender et al (236). It was hypothesized that the allegedly damaged children would manifest a biochemical abnormality by minimum total production of monoamines. Measures of urinary excretion of the principal metabolites of these substances failed to support the hypothesis of biochemical derangement.

Attempts to distinguish normal from psychopathological children by use of cardiac measures have been somewhat more successful. Miller & Bernal (149), using a fairly complex measure based on prestimulus heart rate, found a greater overall response for normal than for schizophrenic children to a tone stimulus. Davies & Maliphant (40) found that under stress adolescent boys judged by their teachers to be refractory had lower base heart rates than matched controls.

There is so little systematic information on the course of human biobehavioral development that it would be inappropriate to criticize those who are struggling with the issues. In this area there is a clear need for programmatic research. The very dearth of information should generate conservatism, particularly in the clinical administration of drugs where the overriding determinant should be the welfare of the particular child. There is little justification provided by the research currently available for the institution of broad scale drug management programs which one suspects are initiated as often for the convenience of caretakers as for the well-being of the treated children.

DEVELOPMENTAL STUDIES WITH ANIMALS

The chicken and its near relatives have apparently replaced the rat as the most popular nonhuman organisms on which to conduct developmentally oriented research. Whether this change is progressive or regressive is left to the reader's evolutionary preferences.

Birds.—Kovach contributed a series of reports which are important not only for substantive reasons but also as models of developmental analysis (117, 118). In a study of perceptual learning it was demonstrated that unlearned color preferences played a significant role in the speed of learning a color discrimination. If chicks were reared in darkness, they subsequently showed distinct color preferences. If they were reared in achromatic light, color preferences disappeared (117, 119). Faster learning occurred after prior exposure to lower light intensities than after exposure to higher intensities. Intensity and preference were found to be additive (118).

A study of the timeliness of intervention was conducted by Adam & Dimond (1). Light stimulation applied on the 19th day of incubation enhanced posthatch approach behavior to a greater degree than stimulation applied on the 15th or 17th day. The writers related their findings to structural changes in the visual system of chick embryos.

The flexibility of late fetal and early neonatal development was demonstrated by Vince & Chinn (227) with Japanese quail chicks. Development was accelerated by placing some eggs next to eggs with 24 hours more incubation time. The experimental chicks, though slightly weaker than their normal sibs, achieved normal ambulation 5 to 6 hours later than their controls.

The effects of sensory interdiction were explored in a study by Nottebohm & Nottebohm (161). They surgically deafened ring doves and found that although this treatment lessened the amount of vocalization, the structure and temporal delivery of vocalizations remained unaffected. Among the deafened birds nest-building and ovulation were delayed and nestlings were not fed sufficiently.

Two studies were concerned with the development of hunger systems in young chicks. Hogan's (89) paper contained an interesting discussion of the mechanisms which may be implicated in converting the basic activities of newly hatched chicks into organized patterns of behavior. Both internal and external factors are included in the account of development change. Wong & Amsel (242) were able to induce instrumental running responses in chicks during the second week of ontogeny. They accounted for the instrumental behavior by postulating the operation of a food-incentive system that refers to the activation of instrumental responding by cues signalling food and not simply to just food itself or to pecking at food.

Nonprimate mammals.—The differential effects of variations of early experience upon later behavior continue to be investigated. Sturgeon & Reid (213) reared rats in impoverished, enriched, and super-enriched environments from 21–81 days of age and tested them on batteries of Hebb-Williams maze arrangements at 122 and 190 days of age. Rearing effects were present on early problems but differences became very small and nonsignificant thereafter. In an investigation by Hughes (91), 35-day-old rats were assigned to derprived or enriched environments for 10 weeks. Half of each group were handled. The dependent variables were measures of exploratory behavior. Handling increased exploratory behavior in rats from the deprived environment but led to a decrease in that activity among rats reared in the enriched cages. There were no overall differences between the enriched and deprived groups. One consistent finding across studies seems to be that a rat reared in a deprived environment is going to become a fat rat which may or may not affect his social life. Perhaps greater consistency in behavioral outcomes might be forthcoming if researchers attempted to define enrichment in rat rather than in experimenter terms.

Since exploratory behavior continues to be a popular test of the differential effects of variations in early experience, researchers would be well advised to pay attention to Goodrick's report on free exploration across ontogenesis (69). Immature through senescent rats were tested for exploratory behavior. Exploratory behavior peaked just after weaning and again at sexual maturity. At all ages females explored to a greater extent than males.

In a series of well-designed experiments, Galef & Clark (53) and Galef (52) explored mechanisms controlling poison avoidance and feeding behavior in wild and domesticated rat pups. In the lead experiment a colony of wild rats was given access to two diets. After their feeding preferences were determined the preferred diet was poisoned with a sublethal dosage. The adult rats avoided the diet that had been poisoned even though it was never again poisoned. Subsequently members of the colony littered. The pups never chose the formerly poisoned diet even though they had never experienced its toxic consequences. In a second experiment it was determined that the pups had learned to eat what the adults were eating and had not learned to avoid what the adults were avoiding. The third experiment eliminated the possibility that the pups' food choices were based either on scent trails left by the adults or by matching-to-sample from bits of food clinging to adults' coats. The fourth experiment demonstrated that the pups followed adults about and thus ate what the adults ate. Wild rats apparently avoid novel foods or foods which have harmed them. The close following of adults by pups provides a mechanism for intergenerational transfer of adult preferences, and incidentally leads to the avoidance of substances which are potentially harmful. The pattern was not nearly so effective in domesticated rats. Whereas none of the wild litters ever ate a single bite of the initially preferred diet, all litters of the domestic groups, after initial avoidance, began to feed on it.

Another series of well-designed experiments on the emergence of long-term memory in the neonatal rat were carried out by Misanin et al (150). Their outcomes were in agreement with the contention that there are two memorial processes, one transient and immune to amnesic agents, the other being susceptible to disruption by such agents. The authors suggested that the long-term memorial process in young rats may be task specific so that demonstrating long-term memory requires careful task selection.

Koepke & Pribram studied the effects of milk on the sucking response in kittens from birth of 6 months (116). The kittens were fed by a stomach loading procedure. Half the animals were given access to a lactating cat, and the other half were exposed to an anesthetized nonlactating cat. For the first 3 weeks there were no differences in sucking between the two groups. From the 4th to the 16th week the group assigned to the lactating female sucked to a significantly greater extent than the nonmilk group. There were no significant differences in sucking between the groups from week 17 through 26. Throughout the 6-month period there were no significant differences between the groups in number of initiations of sucking (nuzzling). The authors concluded that the effect of milk was to prolong rather than to initiate sucking. Since the dry group sucked as much as the milk group during the first 3 weeks, an acquired drive hypothesis cannot be invoked to account for the behavior, yet an unlearned drive hypothesis is not sufficient either since there were significant differences in favor of the milk group during the intermediate period. These conclusions must be accepted cautiously since the first author of the study was the prime observer and obviously was familiar with treatment conditions and objectives. Although some reliability checks on scoring were conducted, the prime observer was probably aware of their occurrence and might possibly have been influenced in her own judgments. Lastly, since the nonlactating cat was also anesthetized, the difference in treatment between the two groups entailed more than just the difference in lactation.

That Piaget has at last achieved scientific respectability was demonstrated in a study by Gruber et al (78) in which cats and kittens at several ages were presented with an object permanence test derived from Piagetian procedures with children. Depending upon one's attitude toward cats, readers will be either pleased or disappointed to learn that the ubiquitous alley variety attained Piaget's Stage IV but not Stages V or VI. The study is reminiscent of bygone days when rats were employed in attempts to demonstrate the operation of Freudian dynamics.

Primate studies.—A number of studies described mother-infant relationships among monkeys. Struhsaker's (212) report on wild vervet monkeys contained detailed descriptions of grooming, ventral clinging, infant caretaking, and other behaviors on several infants observed repeatedly over a 5-month period. He also compared vervet mother-infant behavior with that of other primate species. Wooldridge described the birth and development of colobus monkeys (244), and in three papers Hinde & Spencer-Booth (88, 203, 204) reported on the effects of infant-mother separation on infant-mother pairs in rhesus monkeys, and also on individual differences in infant-mother interaction. They reported that separation produced a depression in locomotor and play behavior and that the severity and durability of the depression was greater as a function of the length of separation. However, differences in spatial environment that produced differences in infant-mother relationships among pigtail monkeys were not enduring (Gastell & Wilson 55).

Gallup & McClure (54) compared captive-born rhesus monkeys reared with surrogate mothers with feral monkeys on preference for mirror-image stimulation. All animals were given a choice between viewing themselves in a mirror or looking at another monkey. The surrogate reared monkeys spent more time looking at the mirror while the feral monkeys preferred to view a conspecific. There was a discussion of the social implications of the rearing patterns and of possible relationships to human pathology.

Sechzer et al (192) examined the development of three types of behavior in normal and neonatally asphyxiated monkeys (*Macaca mulatta*). Visual depth perception, visual placing, and locomotion were delayed in time of appearance in the asphyxiated group relative to the nontreated group, but the behaviors were qualitatively indistinct once they did appear. The absence of impairment of these "developmental" behaviors contrasted with the apparently permanent disruption of learned behaviors in asphyxiated monkeys. Thus a delay in appearance of "developmental" behaviors may have signified brain damage and later mental retardation.

General.—A volume entitled *The Biopsychology of Development* (220), edited by Tobach, Aronson & Shaw, should be of great worth to developmentalists. The volume contains the contributions of participants in a conference held at the American Museum of Natural History. Developmental topics and issues from biochemical to social were discussed. There was a pronounced emphasis on evolutionary considerations, as might be expected in a conference inspired by the late T. C. Schneirla. Two of the contributors discussed regulatory mechanisms implicated in developmental biological organization (33, 231). Sperry contributed a survey of that research in psychobiology over the past 30 years which has acclerated trends toward nativistic interpretations of neurophysiological development (205). Although Sperry's discussion of human intellective development is unsophisticated, it serves to caution readers against adopting overly environmentalist positions. An excellent chapter was presented by Gottlieb (72) on the ontogenesis of sensory functions in birds and mammals. From an ontogenetic point of view man and other primates are unique in having combined the precocial pattern of sensory development with the altricial pattern of motor development. Some implications of this unique pattern of development for perceptual, intellective, and social development were discussed. Gottlieb's analysis of the evolution of species-general and of species-specific phenomena contained important guidelines for comparative and developmental analyses of behavior. Gottlieb also provided a clearly stated set of working assumptions about the relationships of genetic and evolutionary factors to neural and behavioral development. Rosenzweig (179) offered some admonitions against facile interpretations of the early experience literature, pointing out that there is little evidence to show that behavioral differences induced by early enrichment or deprivation are enduring, or that modifications of brain biochemistry are unequivocally related to variations in early learning.

PERCEPTION

The area of perception has been broadened to include complex coding operations involving memory, language, imagery, and visual search strategies. Perceptual processing is viewed by contemporary theorists as a set of interacting operations ranging from initial sensory registration of stimuli to their incorporation in higher cognitive structures and memory. Much of the current research is directed toward discovering the nature of these interacting operations. This review is centered primarily on the development of space perception, abstract spatial operations, and pattern perception.

Size-shape constancy and the perception of depth.—Kaess (103) reviewed several earlier studies of shape constancy. Some indicated an increase in constancy performance with age, others showed a decrease. Kaess attributed these conflicting results to methodological differences, particularly with respect to the construction and presentation of stimulus comparison series. His own studies, controlled for comparison series biases, yielded an increase in shape constancy performance from age 7 through 18 years.

Similar trends have been observed in the development of size constancy (Wohlwill 241). Winters & Baldwin (239) also found that size constancy performance gradually improved with age.

Brown (24) reported a developmental trend in the reconstruction of pictorially represented spatial relationships between the ages of 3½ to 9 years. The subjects were asked to organize spatially objects on a table as they were represented in a picture. The youngest subjects simply placed the objects in random heaps. Accurate placement was not found until after 6 years. These results suggested that children's depth discrimination and constancy performance may break down when depth information is limited to static pictorial cues. It is not clear from the Brown study if the younger children's poor performance was due to a lack of sensitivity to pictorial depth cues or to an inability to reproduce perceived spatial relationships. Wilcox & Teghtsoonian (238) using a procedure which did not involve array reproduction tentatively concluded that younger children lack pictorial depth sensitivity.

Abstract spatial operations.—Laurendeau & Pinard (123) conducted an elaborate series of studies on the development of space concepts of children 2 through 12 years. Their tests included stereognostic (tactile) recognition of forms, construction of projective straight lines, localization of topographical positions, concepts of left and right, and coordination of perspectives. Spatial concepts shifted from topological representation at the youngest ages toward Euclidean mapping of space by older subjects. Only a small percentage of the 12-year-old subjects were able to solve the coordination of perspectives problem.

Piaget's concepts of stage and décalage were discussed in the context of these results.

A number of investigators raised questions concerning the tasks used by Piaget & Inhelder (167) and Laurendeau & Pinard (123) to evaluate coordination of perspectives. Lewis & Fishbein (127) found that children as young as 4 years of age could assume a perspective other than their own when the test involved a simple object rather than a complex scene. Shantz & Watson (198) reported that 3½- to 6-year-old children could assume the perspective of another vantage point if they were allowed to move to the new vantage point and predict the location of objects in a covered array. Unfortunately, the study was confounded and the results are merely suggestive. Furthermore, some relationships in the study were treated as confirmed at levels of statistical confidence which conventionally would lead to retention of the null hypothesis.

Perception of orientation.—The role of spatial orientation of stimuli in perception was investigated in a number of contexts. Deich (41) presented lists of words either right side up or upside down to 2nd-, 6th- and 8th graders. The number of children reading inverted lists nearly as fast as upright lists decreased from 50% in grade 2 to 5% in grade 8. Contrary to Ghent & Bernstein's (56) earlier results with geometric figures, Deich's study indicated that orientation played an increasingly important role in recognition with increasing age.

Asso & Wyke (8) tested children ranging in age from 5 years 6 months to 6 years 10 months on letters similar in form but different in spatial orientation (e.g. b, d). The following methods of assessment were used: direct copying of the letter form; matching the letter to a target embedded in a series of letters; naming the letter; and writing the letter from verbal presentation. Confusability of letters appeared to be dependent on the method of assessment. More errors were made in the naming and writing conditions than in the matching or copying conditions. Reduced memory load may have contributed to the superior performance in the copying and matching conditions.

Discrimination of orientation in Zambian children aged 3½ to 10½ years was examined by Serpell (197), following the procedures Rudel & Teuber (182) used with American children. Children were asked to discriminate and discover the correct stimulus in pairs of lines differing in orientation. Both American and Zambian children had greater difficulty with oblique than horizontal and vertical discriminanda. The general trend in both groups was toward improved discrimination of oblique lines with increasing age. Zambian children's performance lagged behind that of American children by about 2 to 3 years, a difference which might be accounted for by highly disparate educational levels. Olson (164) concluded that children's performance in diagonality discrimination tasks was related to language development, the relationship between perceptual information and performatory action, and cultural factors.

Schema and feature theories of pattern perception.—Theorists concerned with pattern learning and pattern recognition have proposed either schema or feature discrimination explanations for pattern perception. For example, Pick (168) interpreted the outcome of his often cited study as support for feature theory. Caldwell & Hall (28) challenged this interpretation. They suggested that the distinctive features group in Pick's first experiment was given more information regarding the experimenter's definition of same and different. Consequently, discrimination performance was superior in the transfer task involving discrimination of new standard forms with the same feature transforms. Caldwell & Hall reported a reversal of Pick's results when they equated the concepts of same and different for feature and prototype groups. Performance by the prototype group was superior.

Odom et al (162) questioned whether reflection-impulsivity might influence the amount of feature and prototype information used by subjects. Impulsive subjects showed higher overall error rates, but there was no correlation between reflection-impulsivity and the use of distinctive features or prototypes.

Gibson (58) extended distinctive feature theory to auditory and visual perception of words. Developmental differences in sensitivity to word features such as graphological, phonological, semantic, and syntactic markers were noted by Gibson (58, 59).

Eye fixation and scan patterns.—In studies of eye scan patterns it has been found that both children and adults selectively focus on critical or novel features. Mackworth & Otto (134) monitored eye fixations of children age 2–7 years while they were looking at a matrix of 16 white geometric forms. A high rate of visual orienting to items which suddenly changed color was found. Habituation of orienting to the novel event occurred slowly over trials. The orienting and habituation patterns were similar at all ages tested. Other researchers found an age-related shift from relatively unsystematic scanning patterns to greater concentration on regions containing high information when a judgment was required on the basis of the embedded information (133, 158).

Modalities and perceptual development.—The results of cross-modal research frequently have been inconsistent. Furthermore, explanations of the conflicting results reported by different investigators have not been adequate. Goodnow (66) proposed that differences among tasks within a single modality as well as cross-modal task comparisons might be better explained by determining the principles and/or factors common to the processing of information across modalities rather than to continue considering "modality" as a critical factor. Goodnow proposed that intra- and cross-modal research could profitably be directed toward the discovery of common factors involved in perceptual processing. The utility of this proposal may be seen in a review of some of Goodnow's interpretations of her research. From a series of investigations (65–67), she suggested the following common factors: critical or focal parts of stimuli; memory loads; and equivalence of dimensions.

Differences in intra-modal matching of stimuli may occur because stimuli have focal parts, i.e. aspects of the stimulus toward which attention is directed.

If a change is made which affects the focal part, then in a comparison the stimulus would be judged as being different. If the change does not affect the focal part, then the stimulus would be judged as being the same. Use of different modalities may result in different aspects of the stimulus being selected as the focal part. Consequently, same-different judgments of stimuli could be in agreement or in disagreement depending on the modalities and the nature of the stimulus items being used. Predictions of cross-modal comparison outcomes would be dependent on the degree of overlap of the modality-defined focal parts of the stimulus items employed (65, 66).

Modalities may differ in amount of memory load required to perform apparently similar tasks. Cross-modal matching did not show directional effects when only one comparison object was used. However, when three comparison stimuli were used, more errors were made when the subjects felt the standard and looked at the comparison objects than when they saw the standard and tested the comparison stimuli haptically. Goodnow (67) concluded that memory load differences in the tasks involving more comparison objects accounted for this interactive effect of task demand and modality direction.

Equating across dimensions rather than cross-modal integration may be the critical variable in the development of cross-modal matching. Goodnow (68) reported that kindergarten children were unable to match auditory and visual series of stimuli which required equating temporal and spatial dimensions. Second-grade children could perform the task. These age-related differences were interpreted as being due to the children's differential ability to make spatial and temporal relations equivalent. The interpretation was based on the finding that kindergarten children represented differences in temporal spacing of auditory cues by the duration of pauses between a series of dot representations of the auditory patterns, whereas 1st- and 2nd-grade children represented the temporal separation by differential spacing between the dots.

Other contributions to the modality literature include Klapper & Birch's (115) finding that children from age 3 to 8 years match auditory temporal patterns better than visual patterns. They found no differences at ages 9–11 years, but this may have been due to task ceiling effects. The authors suggest that visual and tactual modality differences may be associated with dominant processing modes, temporal in auditory, and spatial in vision. Hermelin & O'Connor (86) have found that 5-year-old children are more accurate in their judgments of duration with auditory than with visual stimuli.

Millar (147) tested the effect of visual and haptic information in training single modality delayed recognition of nonsense shapes with 3- and 4-year-old children and found a general superiority of visual over haptic information processing. Performance with combined haptic and visual cues was not superior to vision alone. In 4-year-olds added visual cues improved haptic recognition.

Information processing.—An information processing approach to perception is characterized by a level and component analysis of information reduction ranging from early registration of stimulus events in the sensory neural networks to encoding in higher cognitive structures and long-term memory (Haith 80, 81). Several studies of low-level processing operations revealed age trends in the temporal resolution of the visual system. Pollack et al (170) found that the dark interval threshold between two light flashes declined linearly between 5 and 17 years. Consistent with Pollack's (169) general theory of perceptual development, the authors attributed improved temporal discrimination to deterioration of the visual receptor system with age.

Thor and his colleagues (207, 217, 218) have shown that dark interval threshold in retardates is more closely related to mental age than to chronological age, a relationship which would not be easily explainable by Pollack's (169) theory. Thor & Thor (218) suggested that the decrease in dark interval threshold with increasing chronological and mental age may be considered an indicator of an increase in processing rate or the developmental refinement of a visual system gaining a higher degree of temporal resolution.

Katz & Wicklund (107) applied an information processing analysis to reading skills. In an analysis of scanning rates they found no difference in the slope of scanning rate function of good and poor readers. There was, however, about a 250 msec difference in intercept value favoring good readers. In a follow-up study testing whether or not good and poor readers differed in simple reaction time, the authors (106) found no differences between the groups. Hoving et al (90) also found similar memory scanning rates for kindergartners, 4th-graders, and college students using familiar forms. As in the Katz & Wicklund study, the groups showed marked differences in intercept values. Thus, scanning rates appeared to be nearly identical across populations, but there are age-related differences in intercept values.

Spring (208) also used an information processing analysis of reading-related skills. Groups of dyslexics and normal subjects ranging in age from 8 to 11 years were tested on a same-different reaction time task using similar and dissimilar upper case letters. Central processing time was estimated by subtracting reaction times to dissimilar letters from reaction times to similar letters. Dyslexics showed slightly longer times on this measure but only during the last half of the testing periods.

Children's organization of dichotically presented lists of numbers was examined in a study by Witelson & Rabinovitch (240). Frequencies of temporal recall (recall of items in the same order as they were presented) and ear order recall (recall of items presented to one ear before recall of items presented to the other ear) responses were similar to those of adults. There was some evidence that use of temporal report order in slow presentation rate conditions was more frequent for high IQ than low IQ children.

Spitz & Borland (206) presented an informational analysis of drawing recognition in children. The number of lines (redundancy) required to recognize an object decreased nonlinearly with age. Most of the improvement in performance occurred between 4½ and 8 years. Pictures recognized by 4½-year-olds were about 30% more redundant than those recognized by 8-year-olds. The authors suggested that with increasing age the child becomes sensitive to more distinctive features on which he can base his identification judgments.

DISCRIMINATION LEARNING AND TRANSFER

Discrimination learning paradigms have served as vehicles for investigating a number of processes and cognitive abilities as well as traditional conditioning variables such as reinforcement properties, incentive levels, etc. Within the context of discrimination learning and associated transfer tasks, a number of issues concerning the nature of mediational processes have been raised, and few have been resolved. Hypotheses have been generated to account for age-related differences in children's ability to perform dimensional transfer shifts (reversal–nonreversal shifts and intra-dimensional–extra-dimensional shifts): the Kendlerian hypothesis of verbal mediation (111), the selective attention model of Zeaman & House (247), and, more recently, hypotheses concerning age-related abilities to inhibit or abandon responding to previously but no longer rewarded stimuli (Gollin & Saravo 64, Johnson et al 101, Sanders 188).

The discrimination learning paradigm has also served as a means of investigating extra-experimental stimulus and response biases which subjects bring to the experimental situation, their effects on performance, and the nature of subsequent learning. The present review is a report on the status of the above-mentioned issues and some comments on the place of these issues in future research. Due to the complexity of the paradigms involving dimensional shifts and the limited space available, the reader is advised to consult the original sources for the specifics of design and method of the studies cited.

Verbal mediation.—The Kendlers have continued to advance the theoretical position of verbal mediation to account for the age-related differential difficulty of reversal vs nonreversal transfer shifts. Kendler & Ward (112) demonstrated that the ease with which stimulus items could be classified into conceptual categories (i.e. labeled with appropriate mediators) affected the difficulty of reversal shift problems for kindergarten (5 years 10 months) subjects. Materials (pictures of real objects) which were related in narrow conceptual categories produced faster reversal shift responding than broadly related materials. Both sets of related materials produced faster reversal shift solution than unrelated materials. Kendler & Ward also found that presenting stimulus items in a cumulative fashion (items remained in view for a block of trials) facilitated reversal shift solution in comparison with single item presentation procedures. The authors concluded that the use of verbal mediators, and thus reversal shift behavior, was in part determined by the nature of the stimulus array.

Limited support for the Kendlerian hypothesis of verbal mediation vs nonmediation has been generated within verbal learning paradigms. Conrad (37) presented pictures, the labels of which were either homophonic or nonhomophonic, to children 3 to 11 years of age. The subject's task was to find the location of a picture face down in a random array and place that picture (still face down) with an identical picture face up in a matching array. Conrad reasoned that if subjects verbally encoded or mediated the material, matching of pictures with homophonic names should be less accurate than that of pictures with nonhomophonic names. If, however, the material were encoded or mediated by some unspecified nonverbal method, matching of homophones and nonhomophones should be identical. Children (MA 3–5) performed equally well with homophones and nonhomophones. Older children (MA 6+) matched significantly more nonhomophones than humophones. The superiority in performance of nonhomophonic material, in addition, was found to increase with increasing mental age. Conrad concluded, consistent with the Kendlerian hypothesis, that prior to 5 years of age children use nonverbal techniques for encoding and processing pictorial material, whereas children 6 years of age and older use verbal methods.

Hall (82) found a somewhat comparable effect in a verbal discrimination paradigm. Hall presented 4- and 5-year-old children with a discrimination task in which the response terms were either phonetically related (rhymed), conceptually related (common category), related in terms of affective control, or unrelated. Only conceptually related material was found to improve performance in relation to unrelated control material. That subjects were not affected by phonetic relationships offers some support to Conrad's hypothesis. Unfortunately, Hall did not collect data with older children which would clarify the validity of Conrad's hypothesis.

The results reported by Kendler & Ward and Hall are consistent with those reported in studies of the organization of memory (cf memory section). The general finding is that young children are able to use experimenter supplied relationships between stimulus items to be remembered as memory aids. The use of the relationships as mnemonic aids is increased if the conceptual categories are familiar and/or concrete and if the materials are presented in a blocked manner. Memory researchers, however, have interpreted these findings as consistent with a production deficiency hypothesis as advanced by Flavell et al (50). Kendler & Ward's results also appear to be consistent with this position in that, if the stimulus array is constructed and presented in a manner that makes a mediator available or salient, young children can and will use it. The availability of the mediator, rather than the presence or absence of mediational abilities, thus appears to be a critical variable for study. It is unfortunate that Kendler & Ward did not sample younger subjects to evaluate conditions in which mediational events might be used by them.

Selective attention.—A number of investigators working within the dimensional shift paradigm have obtained results consistent with a selective attention model rather than the verbal mediation hypothesis. Campione (30), in a complex series of experiments using a variety of transfer shift problems varying the degree of redundancy of stimulus dimensions from original learning to transfer, found that preschool age children solved reversal shift problems with greater ease than extra-dimensional shift problems. Campione concluded that the results were in direct contradiction to the verbal mediation discontinuity hypothesis but consistent with a selective attention model which assumes the presence of a mediational process at all ages. Cunningham et al (39), using similar procedures, also concluded that a selective attention model rather than verbal mediation was consistent with their data.

Campione (31), working with the acquired distinctiveness of cues paradigm, found that pretraining with verbal labels facilitated a subsequent discrimination performance only when the stimulus materials were low in discriminability. For highly discriminable stimuli the effect of labeling during pretraining was no different from simple prior exposure on subsequent discrimination performance. The results suggested that the nature of the mediational process is dependent on the complexity of the stimulus array and the difficulty of the discrimination to be learned.

The selective attention model is not without its problems. A number of investigators have questioned the one-look assumption that subjects attend to only one dimension at a time. Kemler & Shepp (110), using intra- and extra-dimensional shifts, concluded that 8- to 9-year-old subjects learn about both the relevant and irrelevant dimensions during original learning. Brown (22), working with retardates on the oddity problem, came to the similar conclusion that subjects can attend to more than one dimension at a time.

Croll (38) found that 50% of preschoolers tested on a sorting task classified stimulus items on the basis of two dimensions (size and line angle). The remaining subjects were found to sort stimuli on the basis of a single dimension, and they were equally divided between attending to size and to line angle. Croll concluded that the performance of those subjects sorting on the basis of two dimensions was consistent with an attention model in which subjects attend to both dimensions simultaneously but independently.

Bryant (27), in an extensive series of studies, found that location of the relevant dimension within the stimulus array, e.g. color within form boundaries, is an aspect of attention previously ignored. Younger subjects (5–6 years) were more affected by the location of the relevant dimension than older subjects (7–8 years) who attended to the form dimension regardless of the stimuli used. Subjects at both age levels, however, displayed dimensional transfer when location of the relevant dimension was controlled. The "feature positive" effect cited below may also reflect the effects of locational attention rather than strict dimensional attention (Norton et al 160, Sainsbury 186).

Inhibition and/or abandonment of nonrewarded responses.—Gollin & Saravo (64) suggested that much of the developmental variation unaccounted for in discrimination learning performance may be the subject's ability to turn off or inhibit previous responses. The authors further suggested that reversal shift performance may be facilitated by any operation which permits the subject to say "not that one anymore."

Sanders (188) suggested that age-related differences in dimension shift performance was a function of the subjects' ability to "spontaneously abandon"

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previously but no longer rewarded responses. Younger children appear to have difficulty abandoning responses, and thus they demonstrate poorer reversal shift performance. Johnson et al (101) reached a similar conclusion by suggesting that younger children are unable to inhibit responding to their preferred dimension and thus fail on reversal shift problems.

Sainsbury (186) and Norton et al (160) presented data which could be interpreted in a similar manner. They investigated the "feature positive" effect in young children. If the positive stimulus is defined by the presence of the distinctive feature, learning is rapid. If, however, the negative stimulus is defined by the presence of the distinctive feature, learning is markedly retarded. Most subjects tested in these conditions responded to the location of the distinctive feature whether it was located on the positive or negative stimulus alternative. Thus young children may have difficulty inhibiting responding to the salient critical feature.

Sanders (188) was able to facilitate reversal shift performance by instructing subjects on nonreinforced transfer trials that the old stimulus used to be correct but was now incorrect. Performance of younger subjects instructed in this manner approached that of older subjects on reversal shift problems. Johnson et al also suggested that subject's ability to abandon nonrewarded responses could be facilitated, and thus subsequent reversal shift performance would be increased by pretraining. The pretraining consisted of a series of trials in which the subject's preferred dimension was irrelevant or negative in terms of task solution. In both studies (101, 188) it was concluded that the training procedures, either verbal or behavioral, instated a generalized rejection strategy which enabled younger subjects to overcome their initial inability to abandon previously reinforced or preferred dimensional responding. The robustness and generality of the training effects, however, remain to be tested. It is quite possible that the rejection strategy instated was task specific and thus not generalizable across tasks.

Extra-experimental biases.—A large body of data has accumulated concerning dimensional preference in young children. Dimensional preferences have been found to affect learning in a manner consistent with the predictions made from a selective attention theory. In transfer, subjects trained with their preferred dimension (diagnosed by a pretest) relevant perform reversal and intradimensional shifts more rapidly than subjects trained with their nonpreferred dimension relevant (e.g. Dickerson et al 42, Johnson et al 101, Smiley & Weir 200, Seitz & Weir 195). In general, if the subject's preferred dimension is relevant for task solution, performance is improved. If it is irrelevant for task solution, performance is retarded.

Dimensional preferences have been dealt with primarily on a nominal scale of measurement. Subjects have been classified as either form or color preferers with no attempt to evaluate the relative strengths of the exhibited preference. Odom & Mumbauer (163) attempted to devise an ordinal scale by reference to a hierarchy of dimensional preferences. In a study involving subjects 6 to 17 years of age, Odom & Mumbauer found that a majority of subjects at each age level matched stimuli on the basis of form. They also found that when form was relevant for task solution, different aged subjects did not differ in errors to criterion. When color was relevant, however, the two youngest groups (6 and 10 years) made significantly more errors than the older groups. The older groups did not differ in number of errors as a function of relevant dimension. On the basis of these data the authors concluded that (*a*) form was the more salient dimension and thus higher in the dimension preference hierarchy than color; and (*b*) the difference in strength between form and color preferences decreased with age. Overton & Jordon (165) reached similar conclusions [cf Piaget section for details; see also (4, 85) for color name development].

Seitz (194) attempted to quantify differences in strength of preferences and thus generate an interval scale of dimensional preference using factor analytic techniques. By Seitz's procedure of mixed free and forced choice matching triads, a majority (65%) of preschool age subjects were found to have no clear preference. Twenty percent of the subjects matched on the basis of color and 15% matched on the basis of form.

The above results (163, 165, 194) are consistent with a general developmental sequence of preference changes suggesting that a greater proportion of young children prefer color to form and a greater proportion of older children prefer form to color. Seitz extended the hypothesis by suggesting that the developmental sequence terminates when subjects achieve equal preference for both dimensions. Seitz's hypothesis is essentially similar to Odom & Mumbauer's notion of a hierarchy of dimensional preference in which the relative strengths of preferences for specific dimensions become less disparate with increasing age. Odom & Mumbauer, however, placed the achievement of equal preference (i.e. little difference between color and form) at about age 12. Seitz, with her method for assessing preference, suggested that a slight majority of preschoolers have already made the transition to equal preference.

In a follow-up study, Seitz & Weir (195) evaluated the performance of subjects who by Seitz's measure demonstrated no clear preferences for color or form. Preschool subjects were classified into three categories: form, color, and equal preferrers. The effects of the correspondence of the subject's preferred dimension and the relevant dimension in a two-choice discrimination task were evaluated. A large percentage of subjects with strong preferences, either color or form, failed to solve the problem when their preferred dimension was irrelevant for task solution. A finding of particular interest was that subjects with equal preferences were consistently superior to those with strong preferrences even when the latters' preferred dimension was relevant to task solution.

Performance on intra-dimensional vs extra-dimensional transfer shifts for the equal preference subjects was found to be nearly equal. Performance by subjects with strong preferences was found to be consistent with earlier findings: intra-dimensional shifts were easier than extra-dimensional shifts if the shift involved the subject's preferred dimension, but were harder if the shift involved the subject's nonpreferred dimension.

The Seitz & Weir study raises a major question concerning dimensional preference investigations, and that is the issue of availability of a dimension for use and the subject's preferred mode of dealing with a stimulus array (Miller & Harris 152). Seitz's preference testing procedure included both free (both dimensions available for matching) and forced (only one dimension available for matching) choice trials. A majority of preschoolers were found to match on both dimensions with equal frequency across both free and forced choice trials. Does this mean that these subjects had equal preferences, or does it mean that they were able to utilize both dimensions and preference was not necessarily tapped? The idea of preference is that subjects display an affinity for certain dimensions and therefore prefer to attend to them if they are present in the stimulus array. This does not imply that other dimensions are unavailable for use by the subject. It appears that the necessary methodology must ge generated to sort out this issue before dimensional preference can be critically evaluated.

Another methodological problem with dimensional preference research was raised by Tighe et al (219), who found that pretesting to evaluate dimensional preference influenced subsequent task performance when compared with testing for dimensional preference immediately following discrimination training. By pretesting, investigators may be training, explicitly or implicitly, subjects to respond in a manner consistent with current thought about dimensional preference effects. Although this problem is not easily resolved, it should be taken into account as a variable influencing the relationship between dimensional preference and learning.

Rabinowitz & DeMyer (174) raised the issue that the appearance of dimensional preference is, in part, a function of the stimulus array. The authors, in accordance with Trabasso (221), found that, as stimulus items along a dimension increase in discriminability, the salience of the underlying dimension also increases. Thus, if stimulus cues along a dimension are highly discriminable, subjects tend to respond on the basis of the stimulus dimension; if the cues are low in discriminability, subjects tend to respond on the basis of response strategies or position, ignoring the stimulus items.

Brown & Campione (23) raised a similar issue by demonstrating that highly preferred or nonpreferred cues along a dimension (i.e. red or brown respectively) produced responding on the basis of the underlying dimension of color at the expense of responding to form. This relationship was found to hold for 4-year-olds. Three-year-olds, however, were not affected due to the dominance of color preference. The authors concluded that dimensional selection in a preference test is determined by both age-related preference hierarchies and by the nature of the cues on the competing dimensions.

Katz (105) attempted to relate differences in dimensional preference, either color or form, to cognitive style which itself is age-related. Katz found that reflective subjects made significantly more form responses than did impulsive subjects. Impulsive subjects in turn made more color responses than reflective subjects. These findings suggest that dimensional preference may be reflecting an underlying cognitive process.

As is evident from the above review, current models of discrimination learning cannot adequately account for developmental differences in discrimination performance. The inadequacies can be related to two factors: the concept of a simple and/or singular mediational process and an inability of the models to deal with organismic variables such as extra-experimental biases.

The remediation of these problems is difficult but not impossible. As mentioned, the notion of mediational processes has been approached in the context of an either-or question: either subjects of a certain age mediate, or they do not. The question should not be a yes-no proposition but rather a question of degree. Mediation can no longer be thought of as a single unit process, but as a number of processes available to the subject for use in various task contexts. Thus the questions for future research on mediational processes are twofold: what are the conditions which facilitate or impede the use of mediational processes, and what task and/or organismic variables dictate the type of mediational process employed.

Extra-experimental biases can and have been approached in a similar manner. A number of authors have investigated the conditions in which dimensional preferences play a role in learning. The logical extension of this research is the integration of organismic variables such as dimensional preferences into models of discrimination learning. Johnson et al (101) have made some progress in this direction, but the integration is by no means complete.

PAIRED-ASSOCIATE LEARNING

The major work within the paired-associate paradigm has focused on language parameters as variables affecting paired-associate (P-A) learning. Two aspects of language—language (sentence construction) as a mediational event and the semantic aspect of language units (words)—were evaluated.

DiVesta (43) investigated the effects of connotative similarity on the P-A learning of 5th- and 6th-grade children. DiVesta found that P-A learning was most rapid when word pairs were polar opposites as indexed by a single scale of the semantic differential. Learning was also rapid when the word pairs were proximally located in semantic space. Performance was poorest when word pairs were composed of words polarized on separate scales describing semantic space. DiVesta concluded that the connotative elements within word pairs represent relations among words which facilitate associative learning in P-A tasks. The results, however, may have reflected an aspect of inter-pair associative strength, indexed by the semantic differential, rather than a process specific to language structure.

A majority of the work with the P-A paradigm was concerned with the mediational aspects of language, both syntax and semantics. Hughes & Walsh (92) investigated the effects of syntactical mediation in P-A learning by testing the "constraint hypothesis" proposed by Rohwer (175). Rohwer had suggested that different parts of speech exercise varying amounts of constraint on the type of word which may follow them in a sentence. Consequently, if these parts of speech (conjunctions, prepositions, and verbs) are used in the construction of sentential mediators, the utility of the mediator should vary as a function of the degree of constraint imposed by the core word of the sentence. Hughes & Walsh (92) found that the hypothesis held for older (6th grade) children but not for younger children (2nd grade). That is, for 6th-grade children the degree of facilitation was greatest for mediators constructed with verbs and less effective when constructed with conjunctions or prepositions. For 2nd- and 4th-grade children there were no differences in learning when the mediator was constructed with prepositions or verbs, and both were superior to mediators containing conjunctions.

In all cases Hughes & Walsh found that mediators at the three levels of constraint and simple naming of the stimuli produced better learning than the absence of mediators. This general result was found by a number of investigators working with normal children (Lynch & Rohwer 132, Rohwer & Ammon 177) and within a retardate population (Gordon & Baumeister 70, Turnure 223, Turnure & Walsh 224).

The facilitory effect of either subject- or experimenter-supplied mediators found with retardates argues against a mediational deficiency hypothesis of retardate learning (70, 223, 224). Turnure extended the argument against the Luria hypothesis that retardates are bound by inert language functioning and are unable to reverse its functioning under mediating conditions. Turnure & Walsh (224) reported that, if the sentential mediator consisted of a two-sentence paragraph, associative symmetry was found in the recall of educable mental retardates. Backward associates were elicited with nearly equal frequency as forward associates for the two-sentence mediated condition. Single-sentence mediators and simple naming were not effective in increasing backward associates. In a replication Turnure (223) found that it made no difference whether the stimulus and response words were located within the same or different sentences in the two-sentence mediation condition for both learning efficiency and ease of backward associations. Thus these results could have been a function of a generalized increase in meaningfulness of the materials produced by the two-sentence elaboration in relation to single-sentence and simple naming conditions rather than a function of language structure, either syntactic or semantic.

Within the P-A paradigm the finding that pictorial material produced more efficient learning than printed or aurally presented words remained consistent. Hughes & Walsh (92) and Lynch & Rohwer (132) added an interesting dimension to the phenomenon. Hughes & Walsh found that 2nd-grade subjects learned as efficiently from pictorially presented material without the assistance of a mediator as they did from words accompanied by the most elaborate and constrained syntactical mediator. For 6th-grade children, however, learning was more than twice as efficient with verbal materials elaborated with sentential mediators compared with pictorial materials with no overt mediator. In addition, the authors reported that the differences between words and pictures decreased with increasing age. These findings were taken as support for Piaget's hypothesized shift from concrete cognitive operations to verbal-symbolic operations.

Lynch & Rohwer (132) raised some methodological questions concerning testing procedures in comparisons of pictorial vs verbal materials. These authors found that pictorial material facilitated associative learning only if subjects were required to match appropriate picture pairs in the test phase. If subjects were tested with the verbal labels of the picture pairs presented in the study portion of the paradigm, pictorial materials did not facilitate associative learning.

Pictorial response learning was not affected by congruity or incongruity between input (learning) and output (test) modes, but a shift from learning printed words to recognizing pictures had a negative effect on learning efficiency. The finding that incongruity of study and test (input-output) modes differentially affected the associative and response learning phases as a function of type of stimulus materials further complicates the methodological and interpretive implications of P-A tasks for developmental research.

MEMORY

Most research on the nature of memorial processes has focused on the phenomenon of organization of material during the output portion of free recall tasks. Organization, loosely defined as the recall of items in a consistent order independent of the presentation order, is thought to represent an attempt by subjects to encode information to be remembered with a strategy which allows greater and more accurate recall (Tulving 222). Most investigators have found a positive correlation between amount of organization present in subjects' recall and total number of items recalled. This relationship has been interpreted by a number of investigators as evidence that organization of output reflects a cognitive strategy for improving memory for and/or retrieval of information (Cole et al 36, Moeley & Shapiro 153, Neimark et al 156, Rosner 180, Wachs & Gruen 229). In addition, amount of organization and recall have been found to increase monotonically with increasing age for both conceptually related and unrelated material.

The general trend of current research on the topic of organization of free recall has been toward an evaluation of age-related changes in subjects' abilities to utilize experimenter-provided structure in lists to be learned. That is, most research addressed the question: can children use the experimenter-provided structure as a basis of organization to improve recall and what conditions are conducive to its use?

In line with this reasoning, the role of phonetic relationships between items as a basis of organization was examined. In contrast to the data reported on the effects of phonetic similarity on discrimination learning (cf discrimination learning section) phonetically related materials were found to improve performance in a free recall paradigm. Locke (129, 130) found that placing rhyming items in temporal contiguity during presentation improved recall compared to presenting a random list of the same items to 4-year-old children. The rhyming items under the blocked condition tended to be recalled as a unit, and thus phonetic relationships were concluded to serve as a basis of organization (Locke 129).

Rossi & Wittrock (181) evaluated age-related changes in modes of organization of children ranging in MA from 2 to 5 years. Phonetic relationships in the form of rhyming items were used as a basis of organization proportionally more often by younger children (MA 2 years) than older children. Organizational units based on syntactical relationships were found to be most frequent among children of MA 3 years and declined in frequency of use thereafter. Frequency of organization by means of conceptual categories and serial position were found to increase in a monotonic manner with increasing MA; organization by means of conceptual categories increased in a linear manner, whereas frequency of serial position usage was found to be positively accelerated.

Wachs & Gruen (229), in an attempt to evaluate conditions conducive to the use of conceptual category organization as a memory aid, presented 2nd, 4th, 6th, 8th, and 12th graders with word lists in which the items were exemplars of conceptual groupings. The categories were either familiar or unfamiliar, and the items within categories were either high or low in frequency of occurrence. The authors found that the combination of high frequency items and familiar categories produced the greatest amount of clustering and total recall. Unfamiliar categories and low frequency items produced the least amount of clustering and total recall. Clustering was found to improve under all conditions of list structure across trials. On the basis of these data the authors concluded that the occurrence of clustering was dependent on the availability of conceptual categories for use rather than the subjects' ability to use conceptual categories as mediators. In terms of the Flavell et al (50) hypothesis, the failure of subjects to demonstrate clustering under conditions in which the categories presented in the list were unfamiliar, and the demonstration of clustering when the categories were familiar, represents production deficiency rather than a mediational deficiency.

A number of studies evaluating methods of increasing the organization of stimulus items, and thus subsequent recall, appear to be consistent with the production deficiency hypothesis. Cole et al (36) and Moeley & Shapiro (153) found that blocking conceptually related items in contiguous sequences during presentation increased both amount of clustering and total recall. McCarson & Daves (138) found that increasing the number of exemplars within conceptual categories improved category recall and clustering of items within these categories for 4- and 5-year-old children.

Although the concept of production deficiency appears to be well-grounded, Rosner (180) demonstrated some limitations. Rosner, working with subjective organization of unrelated items, found that 5th- and 9th-grade subjects chunked and recalled more items when they were instructed to make up ways the items go together than when they were simply told to rehearse the items. First-grade children, however, did not benefit from the chunking instruction. On the basis of improved recall and organization as a function of chunking instructions, Rosner concluded that the older children demonstrated a production deficiency. The younger children were said to be retrieval deficient since there was a lack of correlation between amount of subjective organization under both chunking and rehearsal conditions and amount of recall. Thus the appearance of production deficiency may be age-related, but it is also dependent on the nature and difficulty of the task.

The task of future research is the investigation of the variables and conditions which affect the discovery and use of task-supplied bases of mediation in both memory and learning tasks in general. Kendler & Ward (112), as well as many of the above-cited authors, seem to be making progress in this direction. If this approach is to be fruitful, the purpose must be changed from determining the age at which children demonstrate mediation to determining the conditions in which subjects at different ages are capable of using mediational processes as learning and memory aids.

CULTURAL, ETHNIC, AND SOCIAL COMPARISONS

Surveying this general literature leads one to believe that if Arthur R. Jensen is deserving of censure on any count, it is the role he has played in stimulating a proliferation of papers of varied quality, many of which contribute little in the way of new knowledge. The Jensen issue, while dealt with explicitly in some investigations, appeared to be the concern of many other investigators who did not allude to it.

In general it was hard to find consistency in definitions of social class, in the instruments employed to assess intelligence (IQ), or in the outcomes of investigations. Determinants of social class were frequently based on family income which is clearly inadequate given the theoretical burden assigned to the social class categorization. Also, in a large proportion of the investigations ethnicity and social class were confounded. The typical comparison was between black lower-class children and white middle-class children. While it was true that contributors often remarked on the dubiety of employing socioeconomic status (SES) as a category, only rarely did they permit their unease to affect the manner in which their results were interpreted.

Instruments for assessing intellective functioning were still predominantly standardized IQ tests although an increasing variety of other devices were utilized. A selection of the instruments was administered either cross-sectionally, longitudinally, or to the same subjects within a short time period. The results often consisted of the usual matrices of correlations and seldom added any new information to the literature.

Outcomes almost exhausted the universe of possibilities. Sometimes there were no significant differences in IQ or other measures as a function of sex, ethnicity, or social class. Sometimes there were differences between social classes or ethnic groups but confined to one or the other sex. Sometimes there were no sex differences, but social class and/or ethnic differences were found. In sum, in most studies disadvantaged children, regardless of ethnic definition, were found to achieve lower IQ scores than nondisadvantaged children but not always. The studies cited below are not necessarily reflective of the observations stated above but have been selected to provide an overall view of the research in this highly important area.

Treatment effects upon IQ scores.—A number of investigators have studied the effects of various treatments on IQ scores. For example, Thomas et al (216)

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compared the impact of two different examiners, *A* and *B*, upon the WISC IQ scores of Puerto Rican working-class children. Examiner *A* was warm and engaging while *B* was business-like. Children tested by *A* achieved significantly higher IQ scores than those tested by *B*. The authors concluded that the style of testing was responsible for the dramatic differences in IQ scores, but they did not address themselves to a further difference between *A* and *B* revealed in the following quotation: "However, while Examiner *B* had never met any of the children before testing them, Examiner *A* had known the children and their families for many years as a result of her participation in other phases of our ongoing longitudinal studies." This aspect of the difference between examiners evidently was not regarded as a possible factor influencing the differences in IQ scores between the groups.

Golden & Birns (61) tested three groups of 18- to 24-month-old children on the Cattell and Piaget Object Scales under standard procedures and under optimal procedures. The parents of one group were black welfare recipients, the parents of the second group were blacks with higher-educational achievement, and the third group had white parents of higher-educational achievement. It was assumed that the white group was of higher SES than either of the black groups. *All* the children were tested first on the standard procedure, and one week later the optimal procedure was administered. There were no significant differences on either test between SES groups, nor were there differences between the groups in amount gained from standard to optimal procedures. All groups showed significant improvement from first to second testing. It is difficult to interpret the outcome since order of procedures was not counterbalanced.

Using the WPPSI as their evaluative instrument, Kinnie & Sternlof (114) tested middle-class white, lower-class white, and lower-class black children aged 4–5 years before and after special training procedures. The procedures were directed at familiarizing the children with test conditions, testers, and test language. All groups showed a significant increase in IQ scores on the full scale WPPSI and on the performance scale but not on the verbal scale. Although it had been anticipated, the lower SES groups did not show a greater gain in IQ scores than the higher SES group.

Jacobson et al (97) tested the effects of cognitive training and of programmed social interaction on the Stanford-Binet scores of young black children whose families had incomes below the federally established poverty line. In the cognitive training sessions (20 hours), the children learned to acquire learning sets under three conditions: reinforcement by social praise and frosted cereal; reinforcement plus modeling the correct response before the child responded; reinforcement plus modeling the correct response immediately after the child responded. The subjects ranged in age from 32–61 months. They were administered the Stanford-Binet prior to and after the training procedures. All three training conditions produced significant increases in IQ scores. The preresponse modeling condition produced greater increments than the other conditions, and the children with the lowest initial IQ scores showed the largest amount of gain. In the social interaction experiment (97) children were given 5, 10, or 20 hours of individual contact with adults. Only those children in the middle IQ groups benefitted substantially from the first to the second IQ test. The overall improvement of the social motivation groups fell far short of that produced by the cognitive training provided in the first experiment.

Group comparisons of IQ scores.—There are many studies which compare IQ performances of black and white children but do not introduce treatment conditions. For example, the WISC scores of black and white children between the ages of 8 and 16 years who were clients in an outpatient clinic were compared by Goldstein & Peck (63). They found that white males scored higher than black males only on the verbal subscales which are assumed to reflect formal education and to be more heavily loaded on environmental factors than performance IQ. Their findings differed from those of many other investigators in that they found no significant full-scale differences between black and white males. When black and white males with low vocabulary scores were compared on the Similarities Subtest, the black males were found to have significantly higher scores. The authors interpreted this finding as indicating that the black males are not necessarily deficient in conceptual skill. Black females had lower scores than white females on all scales, but there were age and clinical referral confounds between the black and white female samples.

Musgrove & Lawson tested black and white Headstart children on the Draw-A-Man Test, and on the Geometric Design and Information Subtests of the WPPSI (155). The white children were found to have a statistically significant advantage only on the Information Subtest.

Snyder et al (201) conducted an item analysis on the Bender-Gestalt protocols of white children in the 1st grade and of black and white 3rd-graders. The black children were classified as an urban disadvantaged group. The report contains useful information about the frequency of kinds of Bender errors made by the groups studied. In general the scores of the black 3rd-graders fell between the scores of the other two groups.

In two papers Scarr-Salapatek (190, 191) discussed theoretical and methodological issues involved in the relationships between IQ and racial and social designations. In addition to presenting extensive data analyses on a large sample of twins, she also presented genetic and environmental models which may be useful in organizing information and generating predictions.

Linguistic factors.—The relationships between a number of linguistic factors and intellective achievement have been examined in a number of studies. Ammon & Ammon (3) pretested 4½-year-old black children from low SES backgrounds on a battery of instruments including the Peabody Picture Vocabulary Test (PPVT), Form B. The children were then divided into three groups. One group received vocabulary training, the second was trained on sentence construction, and the third served as a control. Training was conducted over a 6-week period. The group trained on vocabulary achieved a significantly higher PPVT (B) raw score on the post-test than did the sentence construction and control groups which did not differ from each other. It should be pointed out that effective training on sentence construction may be dependent upon an adequate vocabulary. Furthermore, it would be unfortunate if these results were utilized to discourage training in sentence construction since there is no evidence that the vocabulary and sentence construction training procedures were comparably efficient.

Milgram et al (146) had advantaged and disadvantaged kindergarten and 1st-grade children retell a story which had been read to them. The advantaged children were white, and the disadvantaged group was divided equally between children who were black or white. It had been hypothesized that the disadvantaged would be more handicapped in retelling the essential elements of the story than in the number of words and sentences they could produce. Contrary to expectation, the greater difference between the advantaged and disadvantaged groups was in word and sentence production rather than in thematic production. Among the disadvantaged children there were no differences attributable to race.

Jeruchimowicz et al (100) compared lower and middle-class black children on their knowledge of action and object words. The middle-class children were superior on both categories of words and showed no difference between categories. The lower-class children made significantly more errors on action than on object words. These results must be treated with caution since there was a significant chronological age advantage for the middle-class children.

Berg & Berg (13) tested young black and white children from middle and lower-class families on the PPVT (B) instrument which measures hearing vocabulary. The mean mental age of the black children was 12 months below the mean mental age of the white children. There were no significant differences associated with SES. Only the differences in the score associated with ethnic assignment were significant. The possibility exists that the children categorized as black middle class were not middle class.

In a 1969 paper which has received a good deal of attention, Baratz (10) presented white and black children with a sentence repetition test which contained items in standard English and in black dialect. Baratz interpreted her results as indicating that black children were not bidialectal. Since black children are confronted with school and test situations that rely on standard English, the import of her findings for understanding the performance deficits of these children was considerable. However, a rather sharp critique of Baratz's methodology and statistical analyses has been made by Foreit & Donaldson (51), who suggested that some of the conclusions presented by Baratz may be questionable.

An experiment by Quay (172) also raised questions about the Baratz interpretations. Quay studied the effects of dialect and reinforcement on the Binet scores of black children in Headstart programs. Half of the children were administered the test by means of standard English, and the other half by means of black dialect. Each language group was further divided so that 50 percent received praise during the test and 50 percent were given candy rewards. The testers were blacks. The mean IQ for all groups was about 96; there were no differences in the IQ means between either the reward or language conditions. Although the speech of the subjects was predominantly dialect, they were able to comprehend standard English as well as they comprehended dialect.

Associative and conceptual learning.—Jensen's (99) two-level model of learning, associative and conceptual, has been subjected to examination in a number of studies. Jensen argued that Level I functions such as digit span and rote learning were genotypically independent of Level II functions, which include hypothesis testing, induction, deduction, etc, and furthermore that Level I functions were comparably distributed in lower and upper-class groups, while Level II functions were differentially distributed. Stevenson et al (211) administered Level I and Level II tasks to disadvantaged 5-year-old day care children (mostly black). Although the overall performances of these children were generally poorer than those of white middle-class children, the intercorrelations between Level I and Level II tasks for the two groups were similar, casting doubt on the Jensen thesis.

In an elaborate study, Guinagh (79) also attempted to deal with Jensen's distinction between intelligence (IQ) and basic learning ability (BLA). He was concerned with Jensen's assumption that IQ (Level II) is dependent on BLA (Level I). Inadequate BLA is held to be sufficient to account for poor performance on IQ whereas adequate BLA is necessary but not sufficient for good IQ performance. Guinagh's position was that low IQ is due to cognitive deprivation and that experience with the concepts found on IQ tests should lead to improvement of IQ performances. His experiment was designed to determine whether IQ was functionally dependent upon BLA and whether it was trainable. His subjects were black and white children of low socioeconomic status (SES). They were divided in terms of their scores on a digit span test (BLA), and the experimental groups were given the Raven Progressive Matrices Test before and after sessions in which they were trained in concepts involved in the Raven test. The main effect of treatment was highly significant; all experimental groups exceeded their controls except the black children who had been classified as low on digit span. It was concluded that Raven scores can be substantially improved by appropriate training and that the improvement lasts at least a month. Jensen's claim of a relationship between BLA and IQ was supported in the black but not in the white groups.

Another empirical examination of Jensen's model was conducted by Rohwer et al (178). The subjects were low SES black children and high SES white children in kindergarten, 1st, and 3rd grades. In addition to standard intelligence tests the children were given a variety of paired-associate tasks to measure original learning, retention, and learning-to-learn. The outcomes were counter to predictions deriving from the two-level model. Alternate hypotheses to account for the results were offered. In another paper Rohwer (176) argued that achievement of mastery by rote learning, as Jensen advocates for children from low SES backgrounds, is inappropriate for all children. He speculated that low SES black children had not learned to elaborate spontaneously the materials they are given to learn. The emphasis in school curricula should be upon training which stresses techniques of elaboration.

Longitudinal studies.—There has been an increasing interest in longitudinal studies of the IQ performance of disadvantaged groups. Three hypotheses are current with regard to the relationship between earlier and later measures of IQ among disadvantaged children. The first predicts a systematic decline in the scores of disadvantaged children because of a widening academic gap between them and nondisadvantaged children. The second hypothesis predicts a rise in IQ scores due to school experience, and a third position asserts that there is no systematic relationship between early and later measures. To test these hypotheses, Milgram (145) examined the IQ scores of black disadvantaged children who had been tested yearly from ages 3 through 8 on the PPVT (A) and on the Stanford-Binet, Form LM. While the PPVT (A) mean scores of the children rose significantly from 3 to 8 years, no significant increase in mean score was found on the Stanford-Binet. At no age on either of the tests did the mean IQs approximate the normal range of IQ mean scores.

A longitudinal study was carried out by Hertzig & Birch (87). Utilizing the Stanford-Binet, Form L, they compared the scores of Puerto Rican children of working-class background with the scores of white middle-class children. Both groups had been tested at 3 years and at 6 years and showed a gain in mean IQ of approximately 5 points over that time span. The gain was statistically significant only for the white group. Within groups there was considerable stability of relative position.

In another longitudinal study Goffeney et al (60) compared Bayley Infant Scale scores obtained at 8 months with WISC and Bender scores obtained at 7 years. The black and white children were from families presumably below the socioeconomic and educational mean of the county in which they lived. All significant correlations between the Infant Scales and later tests were low. No 8-month score for black males correlated significantly with any of the later scores. The authors included a worthwhile discussion of methodological and logical issues involved in predicting later from earlier IQ scores.

One study that did contain a report of a large gain over time was conducted by Marshall & Bentler (135). The subjects were 4-year-old disadvantaged minority group children who were tested at the beginning and end of the school year on the PPVT (A). A mean increase of 23.5 IQ points was found. The authors attribute the change to the particular enriched nursery school environment experienced by the children. These results must be interpreted conservatively since there were only 11 children in the sample and there were no control or comparison groups.

Golden et al (62) conducted a longitudinal analysis of the IQ scores of black children of different social class designations to determine when class-related differences in intellectual performance emerge and to identify specific deficiencies that may prevent lower-class children from achieving academically. The Cattell Infant Intelligence Scale was administered at 18 and at 24 months, and the Stanford-Binet was given to the same children at 36 months. No social class differences in IQ scores were found on the Cattell measures, but the lower-class children achieved significantly poorer scores on the Stanford-Binet at 36 months. The mothers of the children were tested on the PPVT. Correlations between mothers and children on IQ performance increased between 18 and 36 months

Piagetian tasks.—Social class, cross-ethnic, and cross-cultural interest in Piagetian tasks has continued since performance on these tasks is assumed to index the level of cognitive development. Wei et al (234) compared white middle-class and culturally deprived kindergarten and 2nd-grade children on a number of Piagetian classification tasks. They hypothesized that the culturally deprived children would show increasing deficits relative to the middle-class children with age. While the culturally deprived children achieved lower scores on the classification tasks than did the middle-class subjects, there was no evidence of a widening performance gap among the older children.

A somewhat different pattern of relationships emerged in a study by Kauffman et al (108), who administered conservation tasks to Headstart and upper middle-class children ranging in age from 28–55 months. They found some indication of a developmental shift in the white middle-class children but no comparable developmental change in the Headstart children. Employing data from both groups of children, they challenged the claim that children as young as 28 months exhibit conservation.

Wasik & Wasik (233) used the Goldschmidt Assessment Kit, which measures conservation, with nongraded primary school children from culturally disadvantaged backgrounds. There were approximately equal numbers of black and white children in the group. These children lagged behind the normative sample by 1–2 years in attained conservation.

Yoruba children served as subjects in a study by Lloyd (128), who presented them with a number of conservation tasks. The age range of the respondents was 3½–8 years, and they were selected from two social groups designated as traditional and as elite. Significant age and social group effects were found. The elite groups had nonsignificantly higher scores than an American middle-class sample. The traditional Yoruba group exceeded the American middle-class group on one of the conservation tasks and was inferior on another of the tasks.

Overton et al (166) investigated the ability of middle-class white and lower-class black children on tasks requiring multiplicative classification. Multiplicative classification involves the ordering of objects at the intersection of two or more classes. In the Piagetian system this skill is based upon the logical grouping termed "bi-univocal multiplication of classes." The children in the study ranged in age from approximately 4 through 10 years. They were presented with two-dimensional and three-dimensional objects in the classification tasks. Dimensionality was counterbalanced. There were no significant differences attributable to dimensionality, nor were there any differences in classification skills among the younger subjects as a function of social class. However, the oldest group of middle-class children significantly exceeded the oldest lower-class children in mean number of correct classifications. Alternative theoretical interpretations are offered for the interaction between social class and age.

Miscellaneous studies.—The impact on the learning and the concept attainment of culturally deprived children of stimulus materials and of reinforcement have been examined in a number of investigations. Bresnahan & Blum (21) hypothesized that children from low socioeconomic backgrounds perform less well on concept-attainment tasks than children from higher socioeconomic backgrounds because they have had inconsistent reinforcement histories. In their experiment they presented 1st-grade children from low and high SES backgrounds with a concept attainment task. One-third of the subjects in each SES group received either zero, 6, or 12 random reinforcements before the criterion run was initiated. The introduction of random reinforcement produced error performances in the high SES group that were comparable to the error performances of the low SES group. Under the zero condition the high SES group made significantly fewer errors than their low SES counterparts, sustaining the hypothesis that the poor performance of the latter group reflected their chaotic or inconsistent reinforcement histories.

Spence (202) tested the assertion that material rewards are more effective than symbolic rewards with culturally disadvantaged children in a learning task. The symbolic reinforcer consisted of a light, and the material reinforcer was a light plus candy. The symbolic reinforcer was generally more effective. Since light (symbolic) and candy (material) reinforcers were not compared with each other in terms of effectiveness, it is possible that the light plus candy condition was inferior because the combination was distracting.

To assess the role of stimulus materials on concept attainment, Securro & Walls (193) presented advantaged and disadvantaged 5th-graders with concept learning tasks employing life-like or artificial (geometric forms) stimuli. No differences in learning were found between the social groups or as a function of the class of stimuli.

Summary.—One overall impression from the literature that has dealt with the cognitive functioning of disadvantaged children is that there has been a surfeit of studies of assessment by standard measures. The emphasis of research should be upon training and sustaining cognitive activities necessary to the achievement of competence. Cognitive competence underlies not only traditional academic achievement but also is likely to be centrally implicated in socially effective behavior and in healthy emotional development.

The entire concept of disadvantage requires a thorough reevaluation. Classifications by SES, degree of intactness of the family, ethnic category, etc, are likely to be more obscurant than enlightening in contributing to the understanding of behavioral change in groups designated as disadvantaged. The focus of research ought to be on the identification and manipulation of the operating variables. Some work along these lines has begun as the review has indicated. However, many of the programs that are undertaken are guided by assumptions with little or no empirical foundation. Given the extant social circumstances, a fruitful direction, applicable to all children and not only to those classified as deficient in some respects, would be to build upon abilities and masteries already available to children. Such a program would require individualized diagnoses of children's skills and handicaps in specific behavioral domains and the construction of training procedures based on the diagnostic information. Aspects of developmental theory should contribute to the efficacy of training programs, but unless theoretical considerations are closely adapted to individual differences, programs will continue to be addressed to ages, stages, or statistical averages and not to human learners.

BEHAVIOR MODIFICATION

An excellent short review of the history, theoretical base, and operating procedures of behavior modification has been presented by Graziano (74). He has also provided a critique of traditional therapies for their "disease entity" models and for their limited delivery capabilities. Perhaps the most important contribution to understanding the rationale, aims, methods, and procedures of behavior therapy was made in a book by Browning & Stover (26), who are members of the staff of the Children's Treatment Center in Madison, Wisconsin. They have provided detailed accounts of how management programs are generated and implemented for children manifesting a wide variety of maladaptive behaviors. There is a worthwhile discussion of ethical problems in general and of the use of punishment in particular. However, the discussion of the problem of long-term effects is not convincing. Like Graziano, Browning & Stover reject the "disease entity" model and rely on the argument that unless parents or some other agents maintain sufficient aspects of the management program, the modified behavior is likely to extinguish. This argument reflects the performance orientation of the operant position and avoids what must be regarded as the essence of any successful therapeutic program, namely, the instatement of coping techniques which will enable the individual to operate more effectively across a range of environmental conditions.

Behavior modification procedures have been used with infants (173), nursery school children (137, 144), children in the primary grades (102, 225), retardates from early ages through adulthood (95, 136, 245), and autistic children (26, 95). The behaviors dealt with included vocalization in infants (173), consumatory behavior (102, 136, 245), aggression (26, 95), simple motor behavior (25, 137, 144, 225), intelligence test responses (185), stuttering (184), and probability learning (109). Control procedures employed varieties of reinforcers: social (2, 25, 26, 136, 137, 144, 173, 225); time out, defined as a period when positive reinforcement is not available or when the opportunity to make responses which will produce positive reinforcement is prevented (2, 26, 74, 95, 136); tokens (9, 26, 74, 185); punishment (26, 74); combinations of and/or comparisons of these and other reinforcers (25, 26, 74, 136, 137, 144, 225). Control procedures also included fading (26, 102), extinction (26, 74, 102), shaping (26, 245), and avoidance (26, 107).

It is not always clear what role the operant procedures play when the behavior is complex. For example, Ryan's (184) report of the effectiveness of operant procedures on stuttering in five otherwise normal children is difficult to interpret. There is no question as to Ryan's effectiveness as a therapist. He individualized the treatment programs and spent many sessions with each child. Only a small part of his program was explicitly operant. Similarly, Sachs (185) reported changes in WISC scores from beginning to end of the school year for a group of eight children enrolled in special education courses. The WISC was the evaluative instrument employed to test the efficacy of a token economy. Token programs were developed to deal with a variety of cognitive skills and maladaptive behaviors, e.g. attention span and tantrums. A significant average improvement in WISC scores from 67 to 80 was observed. There is no way, within the design of the study, to determine whether the token economy, the highly individualized programs, the small teacher-student ratio, or any other factors were specifically responsible for the change.

There were several studies in which parents served as trainers in attempts to eliminate annoying behaviors (e.g. 2, 102). It is difficult to evaluate such demonstrations because there was no systematic observation by the authors of what transpired during the parent-child sessions. This type of report, and others in which incomplete or doubtful outcomes are presented (e.g. 136), should be screened more effectively by editorial reviewers.

Most workers within the behavior modification framework prefer to test the adequacy of their treatment variables by the baseline procedure: the rate of a particular response during a set time period is recorded; a treatment is introduced which is designed to alter the rate of responding; the treatment is eliminated, and rate is again recorded. If rate of response changes as a function of treatment and returns to baseline (extinguishes) when the treatment is withdrawn, the efficacy of the treatment is accepted. While this plan is adequate for trivial behaviors which are studied ad nauseum (pressing telegraph keys, dropping marbles in holes), it is inadequate in other contexts. In clinical situations, if there is success in instating responses which are important for the well-being of the patient (e.g. 245), it would be highly unethical to weaken systematically or eliminate such responses. In situations where management programs are utilized to modify multiple responses (26, 184), sometimes involving months of treatment, extinction procedures would have to take the form of a management program designed to engender pathology, e.g. to make a nonstutterer stutter again.

One solution lies in investigating the efficacy of operant procedures within the framework of small sample designs (144, 173, 225). If transfer tasks were used in conjunction with small sample designs, the test of the efficacy of the treatment procedure would be all the more rigorous. Such procedures would be appropriate in many nonclinical settings but are not likely to be applicable in most clinical settings. In clinical settings the efficacy of the therapeutic program, as distinct from particulars, ought to be evaluated in terms of durability and generalizability of modified behaviors. The introduction of terms such as "self-reinforcement" and "maintaining stimuli" addresses this question but raise difficulties for the theoretical formulations of operant psychology. These terms smell of cognition and may presage the day when we have a cognitive theory guiding an operant technology.

PIAGETIAN INVESTIGATIONS

A number of studies have investigated the relationships between cognitive and linguistic development. Youniss et al (246) trained deaf children in the use of logical symbols. The outcome of the experiment was interpreted as being supportive of Piaget's theory of the development of logical symbol usage and as critical of theories which assert that the employment of logical symbols stems directly from linguistic structures. Stephens & McLaughlin (210) administered 29 Piagetian tasks as well as vocabulary subtests from the WISC or WAIS to normal and retarded subjects. Their findings supported the Piagetian contention that cognitive development was not dependent upon linguistic development. However, language does play a role when verbal report is the only means by which the subject's level of cognitive development can be determined. An illustration of the role of language was provided in studies of conservation by Hamel & De Witt (83), and by Harasym et al (84). In conservation the subjects must comprehend the instructions and, by Piaget's criterion, must provide a verbal explanation of the conservation principles in order to be assessed a conserver. In the above-cited investigations the subject's understanding of the relational terms "same-different" and "more-less" was correlated with the solution of conservation problems in which those terms were implicated.

Several studies have dealt with the factor structure of Piagetian tasks. Bart (11) examined the Piagetian suggestion that formal operational skills are unifactor. Thirty subjects at each of three age levels (13, 16, and 19 years) who were scholastically above average served as subjects. They were given four Piagetian formal thought tasks, three formal operational reasoning tests (biology, history, and literature), and the Experimental Omnibus Vocabulary Test. The Piagetian tasks were found to be unifactor as were the formal reasoning tests. However, tasks and tests taken together were bifactor. The tasks and the vocabulary test were unifactor. The results indicated a substantial formal operational factor and a second factor which is related to content. In another factor analytic study (Berzonsky 14) the unitary nature of logical thinking was tested on 1st-grade children. Twenty-nine Piagetian tasks dealing with causality were presented. Five factors were identified: causal reasoning, concrete operational thinking, problem solving, causal explaining in concrete situations, and understanding the concept of force.

Lee (124) utilized a hierarchical factor analytic method to investigate the relationship between level of cognitive development and level of moral judgment in children ranging in age from 5 through 17 years. She employed six Piagetian tasks and nine morally conflicting story situations. Three orthogonal cognitive components were defined: general cognition, concrete operations, formal operations. With age held constant the concrete operations component was best related to a decrease in authority-type moral responses while the formal mode best predicted an increase of societal and idealistic moral modes of conceptualizing.

Level of moral judgment was also examined by Armsby (5). Children of ages 6, 8, and 10 years served as subjects. They were presented both with standard Piagetian stories and with revised stories designed to differentiate accidental from purposive behavior. A higher percentage of the children made intentionality judgments on the revised than on the standard stories. A majority of the youngest children made judgments in terms of the motives of the actors rather than in terms of the amount of physical damage.

Object concept development continues to be a topic of interest. Landers (122) studied object permanence in infants between 7½ and 10 months, focusing on Piaget's Stage IV in which infants will search for a hidden object at a location (*A*) where it is first hidden but will not also search at a second location (*B*) where the object may be hidden subsequently. Infants who were given more experience in finding an object at the *A* position had more difficulty in locating it at the *B* position than another group with less experience at searching *A*. Infants who did not search themselves but only observed the object at location *A* were also more successful at finding the object at location *B* than the group with the greater *A*-search experience. The motor component involved in the search of *A* was regarded as playing a large role in instating object "representation" since it was the group with the greater amount of active *A* search that had the greatest difficulty in finding the object at the *B* location. Serafica (196) investigated object concept in psychotic children. He compared their responses with preferred and with neutral objects. When the preferred objects were employed, the psychotic children attained Piaget's sixth stage of object permanence, but with the neutral objects these children showed a considerable developmental lag.

The role of stimulus preference on another Piagetian task, multiplicative classification, was studied by Overton & Jordan (165). One object of this well-designed experiment was to test the Piagetian claim that perceptual factors enhance multiplicative classification at age 4 but disrupt the behavior at 6 years. While the claim was not supported, it was found that across the age range a strong preference for color was indicative of a lower level of cognitive functioning than preference for form, size, or number. Perhaps the most interesting finding was that a strong preference for form at age 4 and for number at age 6 differentially predicts overall high performance at each respective age.

Brainerd & Allen (19), in a review of the conservation training literature, concluded that first-order quantitative invariants, represented by the conservation of number, length, substance, and weight, are trainable. Second-order quantitative invariants (volume, density, momentum, and rectilinear motion) remain to be investigated systematically. The authors suggest that the investigations which demonstrated training effects with first-order conservation problems involved treatments that specified operational reversibility in the form of inversion-negation. The critical variable was not the age of the subject but rather the nature of the treatment. In training procedures in which operational reversibility was not or was only partially specified, transfer of training effects were not found regardless of the age range employed. The authors found that most training manipulations produced specific transfer, transfer of the trained conservation principle to novel stimuli. Nonspecific transfer, facilitation of untrained conservation principles, was not found to be the general case.

Brainerd & Allen (20), in an attempt to train second-order conservation principles (density and volume) in subjects 11 to 15 years of age, found that training on density conservation involving specific feedback induced positive transfer to solid volume conservation. Positive transfer was not found for liquid volume conservation. The authors suggested that the differential transfer effects were the result of the similarity of training and test materials used for density and solid volume conservation and the dissimilarity of materials used for liquid volume testing. The differential transfer effect may also have reflected incidental learning about water level displacement (the test of solid volume conservation) which occurred during training of density conservation. That is, during density training the subject was asked whether or not a piece of clay would float in water. The size of the piece was gradually reduced and with each reduction the outcome was demonstrated. Thus, in addition to learning about density conservation, subjects may well have been learning about water level displacement as a function of clay size which would account for the positive transfer found for solid volume conservation. The fact that no such transfer effect was found for liquid volume may reflect the lack of implicit training on this principle as was available for solid volume.

Brainerd & Allen (19) and Miller (148) took issue with the notion of extinction of conservation responding as a method for assessing the efficacy of training procedures. Extinction of conservation was introduced by Smedslund (199) as "countersuggestion." The method involves the violation of conservation principles by deceit. The assumption underlying the procedure is that "natural" conservers would show greater resistence to extinction than trained conservers. Brainerd & Allen (19) and Miller (148), in reviews of the literature, have found that, with the notable exception of Smedslund (199), "natural" and trained conservers do not differ in resistence to extinction by countersuggestion. Thus, on the basis of present data, it appears that trained conservation principles are just as robust as "naturally" acquired principles. This finding may, however, be a function of the methodology employed and, if pushed, trained conservation may indeed fall down.

Finally, the Piagetian assumption that haptic recognition requires the construction of a visual image which incorporates the tactile information was tested by Gottesman (71). In his study congenitally blind and sighted children ranging in age from 2 through 8 years were subjects. All the children first explored objects by tactile means. Half of the sighted groups then chose from four objects in a visual display attempting to select the object previously explored. The remainder of the sighted children and the blind children made the selection in the tactile mode. The results indicated that the blind children and the sighted children who were tested in the tactile mode did not differ in accuracy of selection.

It is clear that adequate systematic inquiry into Piagetian formulations is still lacking. Variations in outcomes as a function of tasks, experience histories, instructions, etc abound. The acceptance of the Piagetian concept of stages, as Suppes (214) has recently pointed out, is essentially uncritical. Elegant discussions of epistemological and developmental issues such as those contained in the volume edited by Mischel (151) may be somewhat premature given the rather uneven condition of the empirical base.

CONCLUSIONS

If sheer output is a measure of vigor, then developmental psychologists are certainly vigorous. In quality terms, however, there is need for upgrading. Probably the best vehicle for accomplishing an overall qualitative improvement is the editorial review. Many inadequately designed studies have been passed into the literature by editors. There can be no excuse for inflicting confounded investigations or papers containing faulty statistical treatments upon readers; nor should editors hestitate to reject contributions because they are trivial even though technical standards of design and statistical treatment are adequate. Although decisions about triviality may occassionally be arbitrary, those making them, the editors, are supposedly selected because they are recognized scholars and scientists whose judgments are thoughtful. The increasing use of "Notes" sections provides a partial solution to the trivia problem by providing a means of publishing minor extensions of previously established relationships and redundant reports.

It ought to be incumbent upon authors to make clear the developmental implications of their work. Unless developmental implications are made explicit, the value of a report for developmental theory is severely restricted, and the direction of further work is likely to be confined to minor empirical extensions.

LITERATURE CITED

1. Adam, J., Dimond, S. J. 1971. The effect of visual stimulation at different stages of embryonic development on approach behavior. *Anim. Behav.* 19:51–54
2. Allison, T. S., Allison, S. L. 1971. Time-out for reinforcement: Effect on sibling aggression. *Psychol. Rec.* 21:81–86
3. Ammon, P. R., Ammon, M. S. 1971. Effects of training black preschool children in vocabulary versus sentence construction. *J. Educ. Psychol.* 62:421–26
4. Anyan, W. R., Quillian, W. W. II 1971. The naming of primary colors by children. *Child Develop.* 42:1629–32
5. Armsby, R. E. 1971. A reexamination of the development of moral judgments in children. *Child Develop.* 42:1241–48
6. Ashton, R. 1971. The effects of the environment upon state cycles in the human newborn. *J. Exp. Child Psychol.* 12:1–9
7. Ibid. State and the auditory reactivity of the human neonate, 339–46
8. Asso, D., Wyke, M. 1971. Discrimination of spatially confusable letters by young children. *J. Exp. Child Psychol.* 11:11–20
9. Axelrod, S. 1971. Token reinforcement programs in special classes. *Except. Child.* 37:371–79
10. Baratz, J. C. 1969. A bi-dialectal task for determining language proficiency in economically disadvantaged Negro children. *Child Develop.* 40:889–901
11. Bart, W. M. 1971. The factor structure of formal operations. *Brit. J. Educ. Psychol.* 41:70–77
12. Berg, K. M., Berg, W. K., Graham, F. K. 1971. Infant heart rate response as a function of stimulus and state. *Psychophysiology* 8:30–44
13. Berg, N. L., Berg, S. D. 1971. Comparison of verbal intelligence of young children from low and middle socioeconomic status. *Psychol. Rep.* 28:559–62
14. Berzonsky, M. D. 1971. Interdependence of Inhelder and Piaget's model of logical thinking. *Develop. Psychol.* 4:469–76
15. Bower, T. G. R. 1971. The object in the world of the infant. *Sci. Am.* 225:30–38
16. Bower, T. G. R., Broughton, J., Moore, M. K. 1971. Development of the object concept as manifested in the tracking behavior of infants between 7 and 20 weeks of age. *J. Exp. Child Psychol.* 11:182–93
17. Brackbill, Y. 1971. Cumulative effects of continuous stimulation on arousal level in infants. *Child Develop.* 42:17–26
18. Brackbill, Y. 1971. The role of the cortex in orienting: Orienting reflex in an anencephalic human infant. *Develop. Psychol.* 5:195–201
19. Brainerd, C. J., Allen, T. W. 1971. Experimental inductions of the conservation of "first-order" quantities invarients. *Psychol. Bull.* 75:128–44
20. Brainerd, C. J., Allen, T. W. 1971. Training and generalization of density conservation: Effects of feedback and consecutive similar stimuli. *Child Develop.* 42:693–704
21. Bresnahan, J. L., Blum, W. L. 1971. Chaotic reinforcement: A socioeconomic leveler. *Develop. Psychol.* 4:89–92
22. Brown, A. L. 1971. Response latencies for intradimensional and extradimensional transfer of the oddity solution. *Psychon. Sci.* 23:389–91
23. Brown, A. L., Campione, J. C. 1971. Color dominance in preschool children as a function of specific cue preferences. *Child Develop.* 42:1495–1500
24. Brown, L. B. 1969. The 3D reconstruction of a 2D visual display. *J. Genet. Psychol.* 115:257–62
25. Brown, R. A. 1971. Interaction effects of social and tangible reinforcement. *J. Exp. Child Psychol.* 12:289–303
26. Browning, R. M., Stover, D. O. 1971. *Behavior Modification in Child Treatment.* New York: Aldine-Atherton. 422 pp.
27. Bryant, P. E. 1971. Discrimination learning and the study of transfer in young children. *Brit. J. Psychol.* 62:1–11
28. Caldwell, E. C., Hall, V. C. 1970.

Distinctive features versus prototype learning reexamined. *J. Exp. Psychol.* 83:7–12

29. Campbell, S. B., Douglas, V. I., Morgenstern, G. 1971. Cognitive styles in hyperactive children and the effect of methylphenidate. *J. Child Psychol. Psychiat.* 12:55–67

30. Campione, J. C. 1971. The effects of stimulus redundancy on transfer of stimulus pretraining. *Child Develop.* 42:551–59

31. Campione, J. C. 1971. The performance of preschool children on reversal and two types of extradimensional shifts. *J. Exp. Child Psychol.* 11:480–90

32. Caron, R. F., Caron, A. J., Caldwell, R. C. 1971. Satiation of visual reinforcement in young infants. *Develop. Psychol.* 5:279–89

33. Caspari, E. 1971. Differentiation and pattern formation in the development of behavior. See Ref. 220, 3–15

34. Claghorn, J., Neblett, C., Sutter, E., Farrell, G., Kraft, I. 1971. The effect of drugs on hyperactivity in children with some observations of changes in mineral metabolism. *J. Nerv. Ment. Dis.* 153:118–25

35. Cohen, L. B., Gelber, E. R., Lazar, M.A. 1971. Infant habituation and generalization to differing degrees of stimulus novelty. *J. Exp. Child Psychol.* 11:379–89

36. Cole, M., Frankel, F., Sharp, D. 1971. Development of free recall learning in children. *Develop. Psychol.* 4:109–23

37. Conrad, R. 1971. The chronology of the development of covert speech in children. *Develop. Psychol.* 5: 398–405

38. Croll, W. L. 1971. Decision processes in multidimensional generalization. *J. Exp. Child Psychol.* 11:206–12

39. Cunningham, T. F., Thaller, K., Campbell, C. 1971. Transfer shift performance of first-grade children as a function of presentation locus of relevant cues. *Psychon. Sci.* 25:221–23

40. Davies, J. G. V., Maliphant, R. 1971. Autonomic responses of male adolescents exhibiting refractory behaviour in school. *J. Child Psychol. Psychiat.* 12:115–27

41. Deich, R. F. 1971. Children's perception of differently oriented shapes: Word recognition. *Percept. Mot. Skills* 32:695–700

42. Dickerson, D. J., Wagner, J. F., Campione, J. 1970. Discrimination shift performance of kindergarten children as a function of variation of the irrelevant shift dimension. *Develop. Psychol.* 3: 229–35

43. Di Vesta, F. J. 1971. The effects of connotative similarity in children's learning of a paired-associate task. *J. Exp. Child Psychol.* 2:35–44

44. Eimas, P. D., Siqueland, E. R., Jusczyk, P., Vigorito, J. 1971. Speech perception in infants. *Science* 171:303–6

45. Eisenberg, L. 1971. Principles of drug therapy in child psychiatry with special reference to stimulant drugs. *Am. J. Orthopsychiat.* 41: 371–79

46. Fagan, J. F. III. 1971. Infants' recognition memory for a series of visual stimuli. *J. Exp. Child Psychol:* 11: 244–50

47. Fagan, J. F., Fantz, R. L., Miranda, S. B. 1971. *Infant's attention to novel stimuli as a function of postnatal and conceptual age.* Presented at Soc. Res. Child Develop. biennial meeting, Minneapolis, Minn.

48. Fitzgerald, H. E., Brackbill, Y. 1971. Tactile conditioning of an autonomic and somatic response in young infants. *Cond. Reflex* 6: 41–51

49. Fitzgerald, H. E., Porges, S. W. 1971. A decade of infant conditioning and learning research. *Merrill-Palmer Quart.* 17:71–117

50. Flavell, J. H., Beach, D. R., Chinsky, J. M. 1966. Spontaneous verbal rehearsal in a memory task as a function of age. *Child Develop.* 37: 283–99

51. Foreit, K. G., Donaldson, P. L. 1971. Dialect, race, and language proficiency: Another dead heat on the merry-go-round. *Child Develop.* 42:1572–74

52. Galef, B. G. Jr. 1971. Social effects in the weaning of domestic rat pups. *J. Comp. Physiol. Psychol.* 75:358–62

53. Galef, B. G. Jr., Clark, M. M. 1971. Social factors in the poison avoidance and feeding behavior of wild and domesticated rat pups. *J. Comp. Physiol. Psychol.* 75:341–57

54. Gallup, G. G. Jr., McClure, M. K. 1971. Preference for mirror-image stimulation in differentially reared rhesus monkeys. *J. Comp. Physiol. Psychol.* 73:403–7

55. Gastell, R., Wilson, C. 1971. Influence of spatial environment on development of mother-infant interaction in pigtail monkeys. *Behaviour* 202–11

56. Ghent, L., Bernstein, L. 1961. The influence of orientation of geometric forms on their recognition by children. *Percept. Mot. Skills* 12:95–101

57. Giacoman, S. L. 1971. Hunger and motor restraint on arousal and visual attention in the infant. *Child Develop.* 42:605–14

58. Gibson, E. J. 1971. Perceptual learning and theory of word perception. *Cogn. Psychol.* 2:351–68

59. Gibson, E. J., Guinet, L. 1971. The perception of inflections in brief visual presentations of words. *J. Verb. Learn. Verb. Behav.* 10: 182–89

60. Goffeney, B., Henderson, N. B., Butler, B. V. 1971. Negro-white, male-female, eight-month developmental scores compared with seven-year WISC and Bender Test scores. *Child Develop.* 42:595–604

61. Golden, M., Birns, B. 1971. Social class, intelligence, and cognitive style in infancy. *Child Develop.* 42: 2114–16

62. Golden, M., Birns, B., Bridger, W., Moss, A. 1971. Social-class differentiation in cognitive development among black preschool children. *Child Develop.* 42:37–45

63. Goldstein, H. S., Peck, R. 1971. Cognitive functions in Negro and white children in a child guidance clinic. *Psychol. Rep.* 28:379–84

64. Gollin, E. S., Saravo, A. 1970. A developmental analysis of learning. In *Cognitive Studies*, ed. J. Hellmuth, 57–90. New York: Brunner/Mazel. 511 pp.

65. Goodnow, J. J. 1969. Eye and hand: differential sampling of form and orientation properties. *Neuropsychologia* 7:365–73

66. Goodnow, J. J. 1971. The role of modalities in perceptual cognitive development. In *Minnesota Symposia on Child Psychology*, ed. J. P. Hill, 5:3–28. Minneapolis: Univ. Minnesota Press. 216 pp.

67. Goodnow, J. J. 1971. Eye and hand: Differential memory and its effect on matching. *Neuropsychologia* 9: 89–95

68. Goodnow, J. J. 1971. Matching auditory and visual series: Modality problem or translation problem? *Child Develop.* 42:1187–1201

69. Goodrick, C. L. 1971. Variables affecting free exploration responses of male and female Wistar rats as a function of age. *Develop. Psychol.* 4:440–46

70. Gordon, D. A., Baumeister, A. A. 1971. The use of verbal mediation in the retarded as a function of developmental level and response availability. *J. Exp. Child Psychol.* 12:95–105

71. Gottesman, M. 1971. A comparative study of Piaget's developmental schema of sighted children with that of a group of blind children. *Child Develop.* 42:573–80

72. Gottlieb, G. 1971. Ontogenesis of sensory function in birds and mammals. See Ref. 220, 67–128

73. Gratch, G., Landers, W. F. 1971. Stage IV of Piaget's theory of infant's object concepts: A longitudinal study. *Child Develop.* 42: 359–72

74. Graziano, A. M., Ed. 1971. *Behavior Therapy with Children.* New York: Aldine-Atherton. 458 pp.

75. Greenberg, D. J. 1971. Accelerating visual complexity levels in the human infant. *Child Develop.* 42: 905–18

76. Greenberg, D. J., Weizmann, F. 1971. The measurement of visual attention in infants: A comparison of two methodologies. *J. Exp. Child Psychol.* 11:234–43

77. Greenwold, W. E., Jones, P. R. 1971. The effect of methylphenidate on behavior of three school children: A pilot investigation. *Except. Child.* 38:261–63

78. Gruber, H. E., Girgus, J. S., Banuazizi, A. 1971. The development of object permanence in the cat. *Develop. Psychol.* 4:9–15

79. Guinagh, B. J. 1971. An experimental study of basic learning ability and intelligence in low-socioeconomic-status children. *Child Develop.* 42:27–36

80. Haith, M. M. 1970. Developmental studies of visual information pro-

cessing and short-term memory. *N. Engl. J. Optom.* 21:240–53

81. Haith, M. M. 1971. Developmental changes in visual information processing and short-term visual memory. *Hum. Develop.* 14:249–61

82. Hall, J. W. 1971. Young children's memory encoding reflected in verbal discrimination learning and recognition memory performance. *Psychon. Sci.* 25:91–93

83. Hamel, B. R., De Witt, S. 1971. The role of language-level in conservation-acquisition. *Scand. J. Educ. Res.* 15:13–20

84. Harasym, C. R., Boersma, F. J., Maguire, T. O. 1971. Semantic differential analysis of relational terms used in conservation. *Child Develop.* 42:767–79

85. Heider, E. R. 1971. "Focal" color areas and the development of color names. *Develop. Psychol.* 4:447–55

86. Hermelin, B. M., O'Connor, N. 1971. Children's judgments of duration. *Brit. J. Psychol.* 62:13–20

87. Hertzig, M. E., Birch, H. G. 1971. Longitudinal course of measured intelligence in preschool children of different social and ethnic backgrounds. *Am. J. Orthopsychiat.* 41:416–26

88. Hinde, R. A., Spencer-Booth, Y. 1971. Towards understanding individual differences in rhesus mother-infant interaction. *Anim. Behav.* 19:165–73

89. Hogan, J. A. 1971. The development of a hunger system in young chicks. *Behaviour* 39:128–201

90. Hoving, K. L., Morin, R. E., Konick, D. S. 1970. Recognition reaction time and size of memory set: A developmental study. *Psychon. Sci.* 21:247–48

91. Hughes, R. N. 1971. Reactions to novelty following differential postweaning rearing and handling. *Percept. Mot. Skills* 32:883–86

92. Hughes, S. E. D., Walsh, J. F. 1971. Effects of syntactical mediation, age, and modes of representation on paired-associate learning. *Child Develop.* 42:1827–36

93. Hunt, J. McV. 1961. *Intelligence and Experience.* New York: Ronald. 416 pp.

94. Hunt, J. McV. 1965. Intrinsic motivation and its role in psychological development. In *Nebraska Symposium on Motivation*, ed. D. Levine, 13:189–282. Lincoln: Univ. Nebraska Press. 344 pp.

95. Husted, J. R., Hall, R., Agin, B. 1971. The effectiveness of time-out in reducing maladaptive behavior of autistic and retarded children. *J. Psychol.* 79:189–96

96. Jackson, J. C., Kantowitz, S. R., Graham, F. K. 1971. Can newborns show cardiac orienting? *Child Develop.* 42:107–22

97. Jacobson, L. I., Berger, S. E., Gergman, R. L. Millham, J., Greeson, L. E. 1971. Effects of age, sex, systematic conceptual learning, acquisition of learning sets, and programmed social interaction on the intellectual and conceptual development of preschool children from poverty backgrounds. *Child Develop.* 42:1399–1415

98. Jeffrey, W. E., Cohen, L. B. 1971. Habituation in the human infant. In *Advances in Child Development and Behavior*, ed. H. Reese, 6:63–97. New York: Academic. 321 pp.

99. Jensen, A. R. 1969. How much can we boost I.Q. and scholastic achievement? *Harvard Educ. Rev.* 39:1–123

100. Jeruchimowicz, R., Costello, J., Bagur, J. S. 1971. Knowledge of action and object words: A comparison of lower- and middle-class Negro preschoolers. *Child Develop.* 42:455–64

101. Johnson, P. J., Warner, M., Silleroy, R. 1971. Factors influencing children's concept identification performance with nonpreferred relevant attributes, *J. Exp. Child Psychol.* 11:430–41

102. Johnson, T. M. 1971. Using parents as contingency managers. *Psychol. Rep.* 28:703–10

103. Kaess, D. W. 1971. Methodological study of form constancy development. *J. Exp. Child Psychol.* 12: 27–34

104. Kagan, J. 1971. *Change and Continuity in Infancy.* New York: Wiley. 298 pp.

105. Katz, J. M. 1971. Reflection-impulsivity and color-form sorting. *Child Develop.* 42:745–54

106. Katz, L., Wicklund, D. A. 1971. Simple reaction time for good and poor readers in grades two and six. *Percept. Mot. Skills* 32:270

107. Katz, L., Wicklund, D. A. 1971. Word scanning rate for good and

poor readers. *J. Educ. Psychol.* 62: 138–40

108. Kauffman, J. M., Payne, J. A., Ensminger, E. E. 1971. Quantitative judgments of culturally advantaged and disadvantaged preschool children. *Psychol. Rep.* 28:939–44
109. Keller, J. R. 1971. Children's acquisition and reversal behavior in a probability learning situation as a function of programmed instruction, internal-external control, and schedules of reinforcement. *J. Exp. Child Psychol.* 11:281–95
110. Kemler, D. G., Shepp, B. E. 1971. Learning and transfer of dimensional relevance and irrelevance in children. *J. Exp. Psychol.* 90:120–27
111. Kendler, H. H., Kendler, T. S. 1962. Vertical and horizontal processes in problem solving. *Psychol. Rev.* 69:1–16
112. Kendler, H. H., Ward, J. W. 1971. Single versus cumulative presentation of stimuli to kindergartners in reversal shift behavior. *Develop. Psychol.* 5:420–26
113. Kessen, W. 1967. Sucking and looking: Two organized congenital patterns of behavior in the human newborn. In *Early Behavior*, ed. H. W. Stevenson, E. H. Hess, H. L. Rheingold, 147–80. New York: Wiley. 303 pp.
114. Kinnie, E. J., Sternlof, R. E. 1971. The influence of nonintellective factors on the I.Q. scores of middle- and lower-class children. *Child Develop.* 42:1989–96
115. Klapper, Z. S., Birch, H. G. 1971. Developmental course of temporal patterning in vision and audition. *Percept. Mot. Skills* 32:547–53
116. Koepke, J. E., Pribram, K. H. 1971. Effect of milk on the maintenance of sucking behavior in kittens from birth to six months. *J. Comp. Physiol. Psychol.* 75:363–77
117. Kovach, J. K. 1971. Interaction of innate and acquired: Color preferences and early exposure learning in chicks. *J. Comp. Physiol. Psychol.* 75:386–98
118. Kovach, J. K. 1971. Effectiveness of different colors in the elicitation and development of approach behavior in chicks. *Behaviour* 37: 154–68
119. Kovach, J. K., Hickox, J. E. 1971. Color preferences and early perceptual discrimination learning in domestic chicks. *Develop. Psychobiol.* 4:255–67
120. Kravitz, H., Boehm, J. J. 1971. Rhythmic habit patterns in infancy: Their sequence, age of onset, and frequency. *Child Develop.* 42:399–414
121. Lamper, C., Eisdorfer, C. 1971. Prestimulus activity level and responsivity in the neonate. *Child Develop.* 42:465–74
122. Landers, W. F. 1971. Effects of differential experience on infants' performance in a Piagetian stage IV object-concept task. *Develop. Psychol.* 5:48–54
123. Laurendeau, M., Pinard, A. 1970. *The Development of the Concept of Space in the Child.* New York: Int. Univ. Press. 465 pp.
124. Lee, L. C. 1971. The concomitant development of cognitive and moral modes of thought: A test of selected deductions from Piaget's theory. *Genet. Psychol. Monogr.* 83:93–146
125. Lewis, M. 1971. A developmental study of the cardiac response to stimulus onset and offset during the first year of life. *Psychophysiology* 8:689–98
126. Lewis, M., Johnson, N. 1971. What's thrown out with the bath water: A baby? *Child Develop.* 42:1053–56
127. Lewis, S., Fishbein, H. D. 1969. *Space perception in children: A disconfirmation of Piaget's developmental hypothesis.* Presented at Psychon. Soc. meeting, St. Louis
128. Lloyd, B. B. 1971. Studies of conservation with Yoruba children of differing age and experience. *Child Develop.* 42:415–28
129. Locke, J. L. 1971. Phonetic mediation in four-year-old children. *Psychon. Sci.* 23:409
130. Locke, J. L. 1971. Acoustic imagery in children's phonetically mediated recall. *Percept. Mot. Skills* 32: 1000–2
131. Luria, A. R. 1963. Psychological studies of mental deficiency in the Soviet Union. In *Handbook of Mental Deficiency*, ed. N. R. Ellis, 353–87. New York: McGraw-Hill. 722 pp.
132. Lynch, S., Rohwer, W. D. Jr. 1971. Effects of verbal and pictorial elaborations on associative learning and response learning in a

children's paired-associate task. *J. Educ. Psychol.* 62:339–44

133. Mackworth, N. H., Morandi, A. J. 1967. The gaze selects informative details within pictures. *Percept. Psychophys.* 2:547–52
134. Mackworth, N. H., Otto, D. A. 1970. Habituation of the visual orienting response in young children. *Percept. Psychophys.* 7:173–78
135. Marshall, M. S., Bentler, P. M. 1971. I.Q. increases of disadvantaged minority-group children following innovative enrichment program. *Psychol. Rep.* 29:805–6
136. Martin, G. L., McDonald, S., Omichinski, M. 1971. An operant analysis of response interactions during meals with severely retarded girls. *Am. J. Ment. Defic.* 76:68–75
137. Massari, D. J. 1971. Reinforcer effectiveness in children as a function of stimulus satiation. *J. Exp. Child Psychol.* 11:310–21
138. McCarson, C., Daves, W. F. 1971. Free recall of object names in preschool children as a function of intracategory variation. *Develop. Psychol.* 4:295
139. McKenzie, B., Day, R. H. 1971. Operant learning of visual pattern discrimination in young infants. *J. Exp. Child Psychol.* 11:45–53
140. Ibid. Orientation discrimination in infants: A comparison of visual fixation and operant training methods, 366–75
141. McKinnon, C., Koepke, J. E., Apland, R. 1971. The effect of social reinforcement on the performance of one-year-old children. *Psychon. Sci.* 23:313–15
142. McNeil, T. F., Raff, C. S., Cromwell, R. L. 1971. A technique for comparing the relative importance of season of conception and season of birth: Application to emotionally disturbed children. *Brit. J. Psychiat.* 118:329–35
143. McNeil, T. F., Wiegerink, R. 1971. Behavioral patterns and pregnancy and birth complication histories in psychologically disturbed children. *J. Nerv. Ment. Dis.* 152:315–23
144. Meddock, T. D., Parsons, J. A., Hill, K. T. 1971. Effects of an adult's presence and praise on young children's performance. *J. Exp. Child Psychol.* 12:197–211
145. Milgram, N. A. 1971. I.Q. constancy in disadvantaged Negro children. *Psychol. Rep.* 29:319–26
146. Milgram, N. A., Shore, M. F., Malasky, C. 1971. Linguistic and thematic variables in recall of a story by disadvantaged children. *Child Develop.* 42:637–40
147. Millar, S. 1971. Visual and haptic cue utilization by preschool children: The recognition of visual and hepatic stimuli presented separately and together. *J. Exp. Child Psychol.* 12:88–94
148. Miller, S. A. 1971. Extinction of conservation: A methodological and theoretical analysis. *Merrill-Palmer Quart.* 17:319–34
149. Miller, W. H., Bernal, M. E. 1971. Measurement of the cardiac response in schizophrenic and normal children. *Psychophysiology* 8: 533–37
150. Misanin, J. R., Nagy, M., Keiser, E. F., Bowen, W. 1971. Emergence of long-term memory in the neonatal rat. *J. Comp. Physiol. Psychol.* 77:188–99
151. Mischel, T., Ed. 1971. *Cognitive Development and Epistemology.* New York: Academic. 423 pp.
152. Mitler, M. M., Harris, L. 1969. Dimension preference and performance on a series of concept identification tasks in kindergarten, first-grade, and third-grade children. *J. Exp. Child Psychol.* 7: 374–84
153. Moeley, B. E., Shapiro, S. I. 1971. Free recall and clustering at four age levels: Effects of learning to learn and presentation method. *Develop. Psychol.* 4:490
154. Moffitt, A. R. 1971. Consonant cue perception by twenty- to twenty-four-week-old infants. *Child Develop.* 42:717–31
155. Musgrove, W. J., Lawson, J. R. 1971. A comparison of lower class Negro and white children on three standardized tests. *J. Negro Educ.* 40: 53–55
156. Neimark, E. D., Slotnick, N. S., Ulrich, T. 1971. Development of memorization strategies. *Develop. Psychol.* 5:427–32
157. Nelson, K. E. 1971. Accommodation of visual tracking patterns in human infants to object movement patterns. *J. Exp. Child Psychol.* 12:182–96

158. Nodine, C. F., Long, N. J. 1971. Development of visual scanning strategies for differentiating words. *Develop. Psychol.* 5:221–32
159. Norman, A., Melville, C. H. 1971. Potential applications of telemetered heart rate data to developmental psychology. *Develop. Psychol.* 5:190–94
160. Norton, G. R., Muldrew, D., Strub, H. 1971. Feature-positive effect in children. *Psychon. Sci.* 23:317–18
161. Nottebohm, F., Nottebohm, M. E. 1971. Vocalizations and breeding behaviour of surgically deafened ring doves. *Anim. Behav.* 19:313–27
162. Odom, R. D., McIntyre, C. W., Neale, G. S. 1971. The influence of cognitive style on perceptual learning. *Child Develop.* 42:883–92
163. Odom, R. D., Mumbauer, C. C. 1971. Dimensional salience and identification of the relevant dimension in problem solving: A developmental study. *Develop. Psychol.* 4:135–40
164. Olson, D. R. 1970. *Cognitive Development: The Child's Acquisition of Diagonality.* New York: Academic. 220 pp.
165. Overton, W. F., Jordon, R. 1971. Stimulus preference and multiplicative classification in children. *Develop. Psychol.* 5:505–10
166. Overton, W. F., Wagner, J., Dolinsky, H. 1971. Social-class differences and task variables in the development of multiplicative classification. *Child Develop.* 42:1951–58
167. Piaget, J., Inhelder, B. 1971. *Mental Imagery in the Child.* New York: Basic Books. 396 pp.
168. Pick, A. D. 1965. Improvement of visual and tactual form discrimination. *J. Exp. Psychol.* 69:331–39
169. Pollack, R. H. 1969. Some implications of ontogenetic changes in perception. In *Studies in Cognitive Development*, ed. D. Elkind, J. H. Flavell, 365–407. New York: Oxford Univ. Press. 503 pp.
170. Pollack, R. H., Ptashne, R. T., Carter, D. J. 1969. The effects of age and intelligence on the dark-interval threshold. *Percept. Psychophys.* 6:50–52
171. Prechtl, H. F. R. 1965. Problems of behavioral studies in the newborn infant. In *Advances in the Study of Behavior*, ed. D. S. Lehrman, R. A. Hinde, E. Shaw, 1:75–98. New York: Academic, 320 pp.
172. Quay, L. C. 1971. Language dialect, reinforcement, and the intelligence-test performance of Negro children. *Child Develop.* 42:5–15
173. Ramey, C. T., Ourth, L. L. 1971. Delayed reinforcement and vocalization rates of infants. *Child Develop.* 42:291–98
174. Rabinowitz, R. M., DeMyer, S. 1971. Stimulus and response alternation in young children. *Develop. Psychol.* 4:43–54
175. Rohwer, W. D. Jr. 1966. Constraint, syntax, and meaning in paired-associate learning. *J. Verb. Learn. Verb. Behav.* 5:541–47
176. Rohwer, W. D. Jr. 1971. Learning, race, and school success. *Rev. Educ. Res.* 41:191–210
177. Rohwer, W. D. Jr., Ammon, M. S. 1971. Elaboration training and paired-associate learning efficiency in children. *J. Educ. Psychol.* 62: 376–83
178. Rohwer, W. D. Jr., Ammon, M. S., Suzuki, N., Levin, J. R. 1971. Population differences and learning proficiency. *J. Educ. Psychol.* 62:1–14
179. Rosenzweig, M. R. 1971. Effects of environment on development of brain and of behavior. See Ref. 220, 303–42
180. Rosner, S. R. 1971. The effects of rehearsal and chunking instructions on children's multitrial free recall. *J. Exp. Child Psychol.* 2:93–105
181. Rossi, S., Wittrock, M. C. 1971. Developmental shifts in verbal recall between mental ages two and five. *Child Develop.* 42:333–38
182. Rudel, R. G., Teuber, H. L. 1963. Discrimination of direction of line in children. *J. Comp. Physiol. Psychol.* 56:892–98
183. Rutt, C. N., Offord, D. R. 1971. Prenatal and perinatal complications in childhood schizophrenics and their siblings. *J. Nerv. Ment. Dis.* 152:324–31
184. Ryan, B. P. 1971. Operant procedures applied to stuttering therapy for children. *J. Speech Hear. Dis.* 36:264–80
185. Sachs, D. A. 1971. WISC changes as an evaluative procedure within a

token economy. *Am. J. Ment. Defic.* 76:230–34

186. Sainsbury, R. 1971. The "feature positive effect" and simultaneous discrimination learning. *J. Exp. Child Psychol.* 11:347–56

187. Sameroff, A. J. 1971. Can conditioned responses be established in the newborn infant? *Develop. Psychol.* 5:1–12

188. Sanders, B. 1971. Factors affecting reversal and nonreversal shifts in rats and children. *J. Comp. Physiol. Psychol.* 74:292–97

189. Satterfield, J. H., Dawson, M. E. 1971. Electrodermal correlates of hyperactivity in children. *Psychophysiology* 8:191–97

190. Scarr-Salapatek, S. 1971. Unknowns in the I.Q. equation. *Science* 174: 1223–28

191. Ibid. Race, social class, and I.Q., 1285–95

192. Sechzer, J. A. et al 1971. Developmental behaviors: Delayed appearance in monkeys asphyxiated at birth. *Science* 171:1173–75

193. Securro, S. Jr., Walls, R. T. 1971. Concept attainment of culturally advantaged and disadvantaged children utilizing artificial and lifelike stimulus tasks. *J. Educ. Psychol.* 62:531–38

194. Seitz, V. R. 1971. Multidimensional scaling of dimensional preferences: A methodological study. *Child Develop.* 42:1701–20

195. Seitz, V. R., Weir, M. W. 1971. Strength of dimensional preferences as predictor of nursery-school children's performance on a concept-shift task. *J. Exp. Child Psychol.* 12:370–86

196. Serafica, F. C. 1971. Object concept in deviant children. *Am. J. Orthopsychiat.* 41:473–82

197. Serpell, R. 1968. Discrimination of orientation by Zambian children. *Rep. 7. Hum. Develop. Res. Unit, Inst. Soc. Res., Univ. Zambia*

198. Shantz, C. U., Watson, J. S. 1971. Spatial abilities and spatial egocentrism in the young child. *Child Develop.* 42:171–81

199. Smedslund, J. 1961. The acquisition of conservation of substance and weight in children. III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance scale. *Scand. J. Psychol.* 2:85–87

200. Smiley, S. S., Weir, M. W. 1966. Role of dimensional dominance in reversal and non-reversal shift behavior. *J. Exp. Child Psychol.* 41: 296–307

201. Snyder, R. T., Holowenzak, S. P., Hoffman, N. 1971. A cross-cultural item analysis of Bender-Gestalt protocols administered to ghetto and suburban children. *Percept. Mot. Skills* 33:791–96

202. Spence, J. T. 1971. Do material rewards enhance the performance of lower-class children? *Child Develop.* 42:1461–70

203. Spencer-Booth, Y., Hinde, R. A. 1971. Effects of 6 days separation from mother on 18- to 32-week old rhesus monkeys. *Anim. Behav.* 19: 174–91

204. Ibid. The effects of 13 days maternal separation on infant rhesus monkeys compared with those of shorter and repeated separations, 595–605

205. Sperry, R. W. 1971. How a developing brain gets itself properly wired for adaptive function. See Ref. 220, 27–44

206. Spitz, H. H., Borland, M. D. 1971. Redundancy in line drawings of familiar objects: Effects of age and intelligence. *Cogn. Psychol.* 2:196–205

207. Spitz, H. H., Thor, D. H. 1968. Visual backward masking in retardates and normals. *Percept. Psychophys.* 4:245–46

208. Spring, C. 1971. Perceptual speed in poor readers. *J. Educ. Psychol.* 62:492–500

209. Starr, R. H. Jr. 1971. Cognitive development in infancy: Assessment, acceleration, and actualization. *Merrill-Palmer Quart.* 17:153–86

210. Stephens, B., McLaughlin, J. A. 1971. Analysis of performances by normals and retardates on Piagetian reasoning assessments as a function of verbal ability. *Percept. Mot. Skills* 32:868–70

211. Stevenson, H. W., Williams, A. M., Coleman, E. 1971. Interrelations among learning and performance tasks in disadvantaged children. *J. Educ. Psychol.* 62:179–84

212. Struhsaker, T. T. 1971. Social behavior of mother and infant vervet monkeys (*Cercopithecus Aethiops*). *Anim. Behav.* 19:233–50

213. Sturgeon, R. D., Reid, L. D. 1971.

Rearing variations and Hebb-Williams maze performance. *Psychol. Rep.* 29:571–80

214. Suppes, P. 1972. *Relevance of research to facts and fantasies of education.* Presented at Am. Educ. Res. Assoc. meeting, Chicago. In *Rep. Preschool Educ.* 4 No. 8:8
215. Surwillo, W. W. 1971. Human reaction time and period of the EEG in relation to development. *Psychophysiology* 8:468–82
216. Thomas, A., Hertzig, M. E., Dryman, I., Fernandez, P. 1971. Examiner effect in I.Q. testing of Puerto Rican working-class children. *Am. J. Orthopsychiat.* 41: 809–21
217. Thor, D. H. 1970. Discrimination of succession in visual masking by retarded and normal children. *J. Exp. Psychol.* 83:380–84
218. Thor, D. H., Thor, C. J. 1970. Dark interval threshold and intelligence. *J. Exp. Psychol.* 85:270–74
219. Tighe, L. S., Tighe, T. J., Waterhouse, M. D., Vasta, R. 1970. Dimensional preference and discrimination shift learning in children. *Child Develop.* 41:737–46
220. Tobach, E., Aronson, L. R., Shaw, E., Eds. 1971. *The Biopsychology of Development.* New York: Academic. 593 pp.
221. Trabasso, T. R. 1963. Stimulus emphasis as all-or-none learning in concept identification. *J. Exp. Psychol.* 65:398–406
222. Tulving, E. 1968. Theoretical issues in free recall. In *Verbal Behavior and General Behavior Theory,* ed. T. R. Dixon, D. L. Horton, 2–36. New Jersey: Prentice-Hall. 596 pp.
223. Turnure, J. E. 1971. Types of verbal elaboration in the paired-associate performance of educable mentally retarded children. *Am. J. Ment. Defic.* 76:306–12
224. Turnure, J. E., Walsh, M. K. 1971. Extended verbal mediation in the learning and reversal of paired-associates by EMR children. *Am. J. Ment. Defic.* 76:60–67
225. Unruh, S. G., Grosse, M. E., Zigler, E. 1971. Birth order, number of siblings, and social reinforcer effectiveness in children. *Child Develop.* 42:1153–63
226. Van den Daele, L. D. 1971. Infant reactivity to redundant proprioceptive and auditory stimulation: A twin study. *J. Psychol.* 78:269–76
227. Vince, M. A., Chinn, S. 1971. Effect of accelerated hatching on the initiation of standing and walking in the Japanese quail. *Anim. Behav.* 19:62–66
228. Wachs, T. D., Cucinotta, P. 1971. The effects of enriched neonatal experiences upon later cognitive functioning. *Develop. Psychol.* 5: 542
229. Wachs, T. D., Gruen, G. E. 1971. The effects of chronological age, trials, and list characteristics upon children's category clustering. *Child Develop.* 42:1217–27
230. Wachs, T. D., Uzgiris, I. C., Hunt, J. McV. 1971. Cognitive development in infants of different age levels and from different environmental backgrounds: An explanatory investigation. *Merrill-Palmer Quart.* 17:283–317
231. Waddington, C. H. 1971. Concepts of development. See Ref. 220, 17–23
232. Watson, J. S. 1971. Cognitive-perceptual development in infancy: Setting for the seventies. *Merrill-Palmer Quart.* 17:139–52
233. Wasik, B. H., Wasik, J. L. 1971. Performance of culturally deprived children on the concept assessment kit—conservation. *Child Develop.* 42:1586–90
234. Wei, T. T. D., Lavatelli, C. B., Jones, R. S. 1971. Piaget's concept of classification: A comparative study of socially disadvantaged and middle-class young children. *Child Develop.* 42:919–27
235. Weizmann, F., Cohen, L. B., Pratt, R. J. 1971. Novelty, familiarity, and the development of infant attention. *Develop. Psychol.* 4:149–54
236. Wender, P. H., Epstein, R. S., Kopin, I. J., Cordin, E. K. 1971. Urinary monoamine metabolites in children with minimal brain dysfunction. *Am. J. Psychiat.* 127:411–15
237. White, B. L. 1971. *Human Infants: Experience and Psychological Development.* Englewood Cliffs: Prentice-Hall. 160 pp.
238. Wilcox, B. L., Teghtsoonian, M. 1971. The control of relative size by pictorial depth cues in children and adults. *J. Exp. Child Psychol.* 11:413–29

239. Winters, J. J., Baldwin, D. 1971. Development of two- and three-dimensional size constancy under restricted cue conditions. *J. Exp. Psychol.* 88:113–18

240. Witelson, S. F., Rabinovitch, M. S. 1971. Children's recall strategies in dichotic listening. *J. Exp. Child Psychol.* 12:106–13

241. Wohlwill, J. F. 1970. Perceptual development. In *Experimental Child Psychology*, ed. H. W. Reese, L. P. Lipsitt, 363–410. New York: Academic. 782 pp.

242. Wong, P. T. P., Amsel, A. 1971. The effect of food deprivation and imprinting on the behavior of young domestic chicks. *Psychon. Sci.* 22:169–70

243. Woodcock, J. M. 1971. Terminology and methodology related to the use of heart rate responsivity in infancy research. *J. Exp. Child Psychol.* 11:76–92

244. Wooldridge, F. L. 1971. Colobus Guereza: Birth and infant development in captivity. *Anim. Behav.* 19:481–85

245. Wright, L. 1971. Conditioning of consumatory responses in young children. *J. Clin. Psychol.* 3:416–19

246. Youniss, J.,- Furth, H. G., Ross, B. M. 1971. Logical symbol use in deaf and hearing children and adolescents. *Develop. Psychol.* 5:511–17

247. Zeaman, D., House, B. J. 1963. The role of attention in retardate discrimination learning. See Ref. 131, 159–223

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BASIC DRIVES

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INTRODUCTION

Many theories of behavior incorporate basic drives as conceptual counterparts to physiological needs, where the specific need refers to a physiological imbalance or tissue deficit which if permitted to persist or accumulate would threaten the existence of the organism. Therefore, the rapid correction of such an imbalance or replenishment of the deficit is of vital importance to the welfare of the individual. Because of the vital importance of need states, physiological psychologists have found it convenient to use the concept of drive in the explanation of animal behavior. The strict behaviorist, on the other hand, has not found it necessary to introduce such concepts.

Drives have also been considered innate capacities to organize sensory stimulation (107) and with appropriate rewards perform a selector function in the acquisition of instrumental responses (110). As most, if not all, basic drive states seem to be manifested by an increased readiness to respond and increased motor activity, it was easy for early theorists to assume frequently the existence of a common or generalized drive state (63, 77, 137) which provided the energy and sustained what was referred to as motivated behavior. The drive state from this point of view determined the pattern of appropriate responses which ultimately relieved the tissue deficit or reduced the physiological imbalance. In this context, an event was reinforcing if its occurrence reduced a drive state (97). Philosophically, these notions have been appealing because they provide a simple scheme for assigning purposes to behavior and enable one to demonstrate easily the adaptiveness, self-determination, and survival value of so-called motivated behavior. Not only have important facts been obscured by these teleological and vitalistic concepts, but the terminology has become imbedded in the scientific vernacular.

Even from a theoretical point of view this type of thinking has not been very fruitful in providing new information. Earlier reviewers (80, 89) emphasized the

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prematurity of theories in this field and indicated that more effort should be expended in the collection of facts and an empirical elaboration of the underlying behavioral processes and physiological mechanisms and their integration in relation to better defined problems. However, the tendency to think along these lines persists and the terminology continues to be confusing. In a recent review (22) the authors indicate that the term drive has probably been employed widely because it can be used loosely, and consequently the concept has disintegrated as a scientific construct. The problem was described aptly and precisely by O'Kelly (109, pp. 59–61) when he stated that "... a major difficulty with attempts to erect physiological theories of motivation is that they all have the aim of describing the physiological and anatomical basis of some group of psychological constructs, with little regard to the suitability of the constructs for either the empirical facts of behavior or the biological 'facts of life' ..."; and that as "a general assumption ... a small number of theoretical constructs, mostly historical residuals of a variety of nonphysiological analyses, must define the problems for physiological explanation ..."; and that "there is not only no attempt to break new ground theoretically, but these theorists have shown little disposition to abandon the old." We agree with these prior reviewers and believe that the term drive has been bandied about to the point where it is not only useless but is actually meaningless and confusing in the literature. We believe that the term serves no scientific purpose and should be abandoned. Alternate explanations for the data are possible which are more parsimonious and less fraught with the mentalism that has characterized the study of human behavior and has been generalized to other animals. Consequently, no attempt will be made to preserve or to introduce the concepts of drive or motivation in the following discussion.

As most of the consideration of this topic in the past has been devoted to ingestive behavior and spontaneous motor activity, it might be fruitful to examine consummatory behavior and motor activity in some detail with the hope of explicating the basis for the general interest in basic drives and motivation during the past 50 years. Because of the interactions between ingestive behavior, temperature regulation, and motor activity, some consideration should be given to behavioral thermoregulation. A number of pertinent reviews which appeared from January 1970 through December 1971 should be mentioned: Behavioral Regulation of Body Temperature, in *Physiological and Behavioral Temperature Regulation* (30); Reexamination of the Role of the Hypothalamus in Motivation, *Psychological Review* (141); Conditioned Appetitive Drive States: Empirical Evidence and Theoretical Status, *Psychological Bulletin* (33); Motor Control Functions of the Lateral Hypothalamus and Adjunctive Behavior, *Physiology and Behavior* (146); The Neural Control of Feeding, *Annual Review of Physiology* (70); Specific Hungers and Poison Avoidance as Adaptive Specializations of Learning, *Psychological Review* (119); The Nature and Determinants of Adjunctive Behavior, *Physiology and Behavior* (48); and four chapters in the 1971 issue of *Progress in Physiological Psychology*—Physiology of Thirst: A Review of the Extra Neural Aspects of the Mechanisms of Drinking (50); Advances in Studies on the Physiological Control and Regulation of Food Intake (84); Lateral Hypothalamic Syndrome: Its Implications for the Physiological Psychology of Hunger and Thirst (46); and the Encephalization of Hunger (138). Because of these relevant comprehensive reviews, we decided to emphasize some of the more theoretical aspects of regulatory processes and question the validity of ingestive behavior as an adequate measure of change in the physiological status of an organism.

THE ROLE OF INGESTIVE BEHAVIOR IN PHYSIOLOGICAL REGULATION

In addition to research on general motor activity, studies on ingestive or consummatory behavior have played a primary role in the historical development of psychophysiological theories of motivation. Ingestive behavior has received considerable attention because it seems to fit a homeostatic model of physiological imbalances and deficits so well. However, self-regulating models such as homeostasis can be misleading (35), and it is very important to determine which variables are regulated and to be able to specify the controls in terms of the actual processes.

Ingestive behavior appears to be controlled by immediate and long-term factors. The duality of control was emphasized recently when it was pointed out that instantaneous eating had received a great deal of attention, whereas an examination of food intake in terms of the adequacy of adjustment to energy output without making any assumption about the method of regulation had not been considered seriously (95). It is not safe to assume merely that regulation occurred, it must be evident from the data. Pertinent variables should not be overlooked because of some preconceived notions as to how the system should operate. For example, momentary energy requirements vary and depend, among other factors, upon level of activity, body weight and composition, body temperature, lactation, and the ingestion of fluids and solid foods. Body temperature depends upon these factors and the ambient temperature as well, and the complexity of the system increases rapidly as different interactions between the variables become significant.

The important question once regulation is evident is what is being regulated at the moment. For example, because of increased motor activity body weight might be reduced and a new set point established with a resultant decrease in food intake (26, 27). Under these circumstances regulation is inferred from the careful observation of correlated changes between the values of these different variables, and determining the contingencies between them can be very difficult. As one author points out, food intake is not regulated but is controlled in a process of regulation (84). In this context eating by itself is of no special interest even though the ingestive behavior produced the food intake. Eating is important at the moment for short-term regulation, but the long-term changes appear only in the values of food ingested per day over several months. Although the two sets of numbers are related, at any moment one might be a poor measure of the other. The most rudimentary measure of ingestion, amount consumed, might not only be an unreliable indicator of regulation but specious as well. Falk (49) recently arrived at a similar conclusion regarding the measurement of ingestion and posed the question, "What are we measuring when we measure ingestive behavior?"

In general, man in our society and the rat in the laboratory colony are not suffering from any deficiency in sources of calories or fluids and therefore eat and drink mainly because ingestive behavior is an integral part of daily activity patterns well ingrained within the organism and controlled by a complex set of internal and external environmental stimuli (52). Ingestive behavior in adult rats and man evidently develops early in life from reflexly induced sucking (138) and might be conditioned. Even prandial drinking in the weanling rat seems to be acquired through practice (78). Is ingestive behavior already conditioned in the adult? If eating and drinking are unconditioned responses evoked by various appropriate enteroceptive unconditioned stimuli, why are they difficult if not impossible to condition? In a recent review of studies on "conditioned appetitive drive states" the authors point out that eating and drinking have not been very sensitive or reliable measures of level of deprivation, and it is not clear if the experimental animals demonstrated adequate discrimination of the external cues or "... differences in the intensity of their internal drive state ..." and therefore a reliable demonstration of "... conditioned hunger or thirst ..." has not been produced (33, p. 217). Three reports have appeared recently (124, 125, 147) which indicate that drinking induced by administration of hypertonic saline might be conditioned to a complex stimulus and that the so-called conditioned drinking under these conditions is very resistant to extinction. It is interesting to note that after bilateral lateral hypothalamic lesions, presentation of the complex conditioned stimulus still elicited the conditioned drinking, but the unconditioned stimulus, the enteroceptive effects of the hypertonic saline injection, no longer elicited drinking (147). There is some recent evidence which indicates that hypothalamic neuron electrical activity sensitive to changes in blood glucose can also be conditioned to acoustical stimulation (81). The role of conditioning in the development of the controls of ingestive behavior is undoubtedly complex, and many more factors such as insulin release in conditioned hypoglycemia (73, 130) will have to be studied in greater detail before the extent of its involvement can be determined.

Another interesting phenomenon which casts some doubt on the adequacy of ingestive behavior in the physiological regulation of energy balance is anorexia during refeeding after starvation (66); this anorexia can be intensified by voluntary wheel-running activity (155) and actually lead to death (135). Obviously the ingestion of food and imbibition of water are essential in the long-term replenishment of physiological deficits, even if they are inadequate at the moment. In addition, the large safety factor which usually permits a wide margin of error can be reduced drastically by relatively short-term increased energy demands, and then the system fails to protect the individual adequately. Consequently, the specificity of ingestive behavior and consumption data must be examined very carefully in terms of relevance to other physiological and behavioral variables, and appropriate tests must be incorporated into the design of future experiments to substantiate the validity as well as the reliability of the measures.

INGESTIVE BEHAVIOR, THE LATERAL HYPOTHALAMUS, AND THE RETICULAR FORMATION

Motor capacity or response repertoire is limited, and certain activities have a high probability of occurrence for a specific environment. For example, grooming is a common self-directed activity in the rat and accounts for 40% of its home cage behavior (17). Self-directed activity and wheel running are generally referred to as spontaneous activity and indicate changes in the level of excitability in the motor system. Such an explanation for spontaneous motor activity has been widely accepted (21), but the fact that a similar mechanism might be involved in ingestive behavior requires further elucidation. Some recent observations on behavior elicited during electrical stimulation of the lateral hypothalamus (LH) and schedule-induced behavior (146) indicate that the same or similar neural mechanisms might be involved in the development of stimulus control for ingestive behavior from an ongoing pattern of general motor activity. In other terms, how does ingestive behavior emerge from the ongoing motor behavior when a deprived animal is in the presence of food or water and how is the behavior sustained? Another important question concerns the lateral hypothalamus. Why is it intimately involved in the control of both ingestive behavior and motor activity? The answers to both questions seem to be related.

During the process of deprivation, ingestive behavior occurs when the internal effects make it possible for environmental stimuli to initiate chewing, licking, and other movements in the presence of objects that have been bitten, licked, and consumed in the past. The internal changes undoubtedly decrease the threshold, increase the excitability of motor pathways, and movements begin to occur. With ingestive behavior a considerable amount of interaction takes place between the motor movements and sensory stimulation arising from the muscle movements themselves and the substances handled, bitten, and consumed. These physiological processes once initiated seem to be sustained by the oropharyngeal sensory feedback and other ingestional stimulation.

The same type of process appears to occur more rapidly in a similar environmental situation during LH electrical stimulation in the sated rat (141, 151). The initial discrete movements, tail chasing, and preening begin to diminish in frequency, and those activities with oropharyngeal and gastric sensory feedback such as carrying objects with the mouth, chewing and ingestion of food, licking and imbibition of water, increase in occurrence and continue for longer periods during the stimulation. Another interesting feature of such stimulation is that the behavior can be switched by changing the environmental stimuli without altering the pattern or intensity of the stimulation through the electrodes (141). The elicitation of behavior under these conditions and switching can be facilitated or inhibited by the manipulation of oropharyngeal sensory feedback. For example, the elicitation of drinking can be enhanced by the addition of saccharin or inhibited by quinine hydrochloride (151). Electrical stimulation of the LH undoubtedly produces some effects very similar to normal enteroceptive stimuli involved in the elicitation of ingestive behavior. However, it does not by itself evoke eating, drinking, or any other behavior. It does seem to increase the probability that any response will occur to any above threshold stimulus (146). In other words, the probabilities that movements will occur in the presence of the appropriate environmental stimuli are increased during LH stimulation. The effect of LH stimulation seems to be nonspecific and refers only to the behavior elicited during the electrical stimulation of the LH and not to a specific neural effect which might be produced.

Similar mechanisms might be involved in the development of ingestive behavior following food or water deprivation. Such changes can be overlooked very easily under these conditions but are obvious to the experimenter who carefully observes the animal during LH electrical stimulation in the presence of water and food. Initial amounts consumed on a mild deprivation regime are usually small and probably insignificant in terms of fluid regulation. Several days on such a schedule are required before amounts ingested increase sufficiently, and several weeks can elapse before consumption and body weight stabilize at what appear to be physiologically adequate levels. Under the same conditions rats will drink copious amounts of fluid during the first several days if the water is flavored with saccharin (unpublished personal observations).

A similar phenomenon occurs in man and has been referred to as voluntary dehydration (2). In man the dehydration can also be corrected by making the water more palatable by cooling it and adding artificial citric flavoring (147). Peripheral stimulation associated with ingestive behavior is relatively powerful in the control of eating and drinking in the regulation of body fluids and metabolism (83, 106). However, enteroceptive stimuli seem to be ineffective and are apparently unknown to most people in terms of verbal association. Wolf has documented the "elusiveness of thirst as a sensation in man" (153).

The difficulties with measures of ingestive behavior as quantitative indicators of change in physiological conditions might be attributable to some neural peculiarities of the lateral hypothalamus and its relations to the reticular formation motor control systems. At present it is not possible to determine if internal stimulation alone is a sufficient condition to produce eating and drinking, nor is it clear as to whether or not eating or drinking will occur for a given set of conditions. The lack of behavioral specificity might be due to a high degree of convergence of cells of the lateral preoptic-lateral hypothalamic medial forebrain region upon mesencephalic and brain stem motor control systems.

The lateral preoptic-lateral hypothalamic medial forebrain bundle region of the hypothalamus, which must play a prominent role in the interaction between ingestive behavior and motor activity, is characterized by the long medial forebrain bundle fibers and a series of neuronal loops interconnecting the extensive dendrites of the path neurons. Rostral path neurons receive a unique contribution from the medial preoptic and anterior hypothalamic nuclei, whereas progressively caudal path neurons receive their primary supply from the ventromedial and premamillary nuclei (99, 100). In general, the lateral preoptic-lateral hypothalamic region has a common afferent source from the medial forebrain longitudinal fiber system with considerable additional input to the rostral portion from the amygdala, piriform cortex and olfactory tubercle, and a large afferent supply to the caudal regions from the ascending reticular formation. Although there appear to be reciprocal connections from the lateral preoptic area to the septal nuclei, olfactory tubercle, anterior olfactory nucleus and amygdala, the major efflux of fibers from path neurons and other medial forebrain sources seems to be into the mesencephalic tegmentum where they make extensive contacts with reticular neurons and form a structural intermediary connecting forebrain-hypothalamic regions with autonomic and somatic motor systems in the lower brain stem and spinal cord (99, 100).

Recent studies utilizing histochemical fluorescence (139) and selective lesions produced by intracerebral injection of 6-hydroxydopamine (140) reveal that the dopaminergic nigro-striatal pathway which ascends in the lateral hypothalamus is involved in ingestive behavior and the control of motor system excitability and activity. The exact role of the corpus striatum is not clear, but it apparently inhibits diencephalic excitatory mechanisms related to eating and motor activity and if partially destroyed produces hyperactivity. Ungerstedt (140, p. 116) was forced to conclude that "... the role of the striatum is in all probability not one of regulating eating and drinking specifically. When considering the curious hypokinesia, lack of exploratory behavior and difficulty to initiate activity that occurs after selective lesions of the nigro-striatal DA [dopaminergic] system, it is more probable that the DA system and the striatum control a general arousal ... that is necessary for performing a number of activities, where eating and drinking deficits are noticed only because they are easily measured by the observer and disastrous to the animal." Additional pathways in both the lateral hypothalamus and ventral tegmentum must be involved in motor control functions because selective destruction of the nigro-striatal axons in these two structures does not result in the catalepsia and somnolence observed following electrolytic lesions in these same regions (140).

The caudal hypothalamus, ventral tegmentum, and mesencephalic reticular formation have been implicated in eating and drinking, coordination of movements, motor activity, and sleep (16, 28, 57, 91). However, in most of these studies no attempt was made to determine if the effects were specific to ingestive behavior or resulted from a general hypokinesia and catalepsia. In one study where the effects of the lesions were assessed both in terms of eating and drinking and specific motor tasks, a clear dissociation of aphagia and hypokinesia appeared which was related to neuroanatomical locus (11). Although all the experimental animals were less active than controls, hypokinesia was most pronounced in those animals with posterolateral LH lesions that apparently destroyed the nigro-striatal dopamine system; whereas lesions in the anterolateral region of the LH which produced the most severe aphagia had the least effect on motor activity. Although there was considerable overlap between the lesions, results suggest a partial separation of two systems with different functions.

Osmosensitive cells of the lateral preoptic region (14) and osmo- and glucosensitive lateral hypothalamic neurons (114, 148) involved in eating and drinking apparently converge in the rostral LH. Therefore, electrical stimulation of the LH might provide nonspecific partial stimulation of this motor control system which includes the caudal lateral hypothalamus, ventral tegmentum, mesencephalic and brain stem reticular formation. For example, thermosensitive cells of the preoptic area excite cells of the lower reticular formation which control the activity in gamma efferents and indirectly the excitability of the reflex pathways in which those afferents from the muscle spindles participate (144). Both synergistic inhibitory and facilitatory influences are enhanced and the reciprocal and coordinated nature of reflex activity and movements is preserved. Direct connections with spinal motoneurons might provide the basis for the initiation of rapid reflex activity and movements (74, 128).

Apparently these cells whose activity depends upon variations in blood temperature and composition above or below some preadapted range converge in the crucial middle portion of LH onto the anterior path cells of the caudal region which also receive a rich supply of afferents from the ascending reticular formation. The entire extent of the lateral hypothalamic region appears to receive considerable excitation from taste, oropharyngeal and gastric, tactile, visual, auditory, olfactory, and muscle receptors (19, 45, 76, 105, 108, 154). Consequently, the motor control functions of LH can be modulated easily by a variety of peripheral stimuli but primarily those from the tongue and mouth. The LH appears to be intimately involved in a brain stem motor control system (149) which determines the normal level of spinal reflex excitability and motor activity (56, 96). The mechanism by which these effects are carried out involves the supraspinal control of the alpha motoneuron and the dynamic and static fusimotor systems (74, 128). Electrical stimulation of the central and posterior regions of LH produces a nonspecific enhancement of spinal reflex excitability (44) which seems related to the posterior hypothalamus induced nonreciprocal fusimotor effects on hind leg muscle spindles (129). It is interesting that electrical stimulation of the basolateral amygdaloid nucleus, which inhibits some cells of the LH (113), results in the production of lumbar ventral root reflex discharges (44). Electrical stimulation medial to the fornix also produces ventral root reflex discharges. Both the vestibulospinal and rubrospinal descending fiber systems have monosynaptic excitatory connections on spinal motoneurons (128). A very high frequency of discharge of lumbar motoneurons occurs when the hypothalamus and red nucleus are tetanized (128). The effect is greater with extensor motoneurons. Such a neural mechanism might be destroyed in the prerubral syndrome of aphagia and adipsia reported recently (154) and this would explain the inability to execute ingestive behavior.

Although it appears that fibers all along the motor path from the cerebral cortex contribute to the gamma fusimotor system, the greatest concentration and most profuse connections occur in the collecting network of the reticular formation from the diencephalon down to the spinal cord. The effects become less diffuse and more specific from the diencephalon into the lower brain stem where reciprocal reflex activity organized at the level of the spinal cord can be elicited (43). Powerful excitatory as well as inhibitory effects on motor performance can be obtained from electrical stimulation of the reticular formation, and it is reasonable to assume that such activity occurs normally in the healthy animal. Therefore, it is not surprising to discover that lesions in midbrain structures produce classical LH deficits (16, 91). In addition, the evidence that an ". . . ascending reticular formation pathway which follows a course ventrolateral to the periaqueductal gray matter in the midbrain and subsequently descends into the region of the zona incerta and fields of Forel at caudal hypothalamic levels" is also necessary for normal ingestive behavior is very important (16, p. 593). The fact that the LH is essential for normal motor activity, which depends upon somatosensory as well as enteroceptive and exteroceptive stimulation, as mentioned previously, has only been appreciated recently (93). In addition, LH electrical stimulation has a perplexing effect on tactile stimulation in the snout and mouth region which not only lowers the threshold for biting but increases the size of the responsive area (92, 132). Therefore, an appropriate afferent input at least into the caudal portion of the LH seems to be necessary for normal functions.

To speculate briefly, the lateral hypothalamus might be unique because it is the confluence of several motor control systems and the convergence of rostral thermosensitive, osmosensitive, and glucosensitive cells on these or parallel motor systems which pass into the mescencephalic and brain stem reticular formation. Consequently, as the ascending reticular formation sends a profuse supply of afferents into the caudal region of the lateral hypothalamus, a possibility for positive feedback exists for those enteroceptive inputs at this level into the reticular motor control system. Therefore, an increase in enteroceptive stimulation will produce a nonspecific increase in the excitability of the diencephalic and mesencephalic motor control systems with activation of specific reciprocal brain stem effects on spinal reflexes. Motor activity will be elicited both by environmental exteroceptive stimulation and proprioceptive stimuli arising from the muscle movements themselves. Under these conditions those movements which result in an increase in positive sensory feedback will be sustained. It is also interesting that some types of stimulation seem to be prepotent. Cutaneous nerves are more effective than muscle nerves in increasing fusimotor discharge, and sensory input from the tongue and mouth appears to be more widely distributed throughout the LH and very efficient in sustaining certain aspects of ingestion such as licking.

Because of our present research interests we have emphasized some of the difficulties encountered in the use of behavioral measures to study regulatory processes and the role of the lateral preoptic and lateral hypothalamic region in the control of motor activity and ingestive behavior. The remainder of the article will examine behavioral thermoregulation and some aspects of the control of ingestive behavior not covered by the other recent reviews.

BEHAVIORAL THERMOREGULATION

Although physiological thermoregulatory responses to heat and cold have been studied intensively for many years, the investigation of behavioral contributions to thermoregulation in homeotherms have only recently received significant attention. Undoubtedly, the demonstration of the facility with which rats perform an operant response to maintain ambient thermal neutrality has been a major impetus in developing interest in the area of behavioral thermoregulation (150). The recent handbook on behavioral regulation of temperature attests to a rapidly growing literature in this field (69). While it is recognized that a rich comparative literature has been developed concerning behavioral thermoregulation in poikilotherms, the focus here will be on homeothermic species, primarily the rat and monkey. These species were selected because for both the thermal stimulus has been precisely specified and neural mechanisms have been considered.

Briefly, the basic paradigm in behavioral thermoregulatory studies incorporates placing an animal in an environment with the temperature displaced from the neutral level for that animal and then reinforcing an operant response with a brief change in temperature in the direction of neutrality. As is well recognized, behavioral studies in this area offer unique opportunities in that the antecedents and consequences of behavior can be specified simply in terms of temperature, although precise control of a thermal stimulus is difficult. Recent developments, however, have gone a long way in coping with the technical difficulties inherent in accurate control of the stimulus (94). By using a forced-air convection system, it is possible to change temperature rapidly and precisely and to approximate square waves of varying duration and amplitude. With this method, response rate for thermal reinforcement was shown to increase sharply as a function of the magnitude of the displacement of ambient temperature from neutrality. In addition, increases in duration and magnitude of the thermal reinforcement decreased response rate but only if the thermal reinforcement was on the opposite side of neutrality from the ambient temperature.

Manipulation of hypothalamic temperature has also been employed in a number of studies and results are generally consistent and straightforward. If hypothalamic temperature is displaced from neutrality, animals will work for a change in skin temperature at the opposite side of neutrality. Conversely, if skin temperature is displaced from neutrality, animals will work for changes in hypothalamic temperature at the opposite side of neutrality. However, one study illustrates some limitations with this simple scheme by showing that when hypothalamic cooling but not heating is prolonged, behavioral thermoregulatory responding for changes in skin temperature no longer occur (1). Also, hypothalamic and skin temperature interactions were studied utilizing a water-perfused thermode in the hypothalamus in conjunction with a forced-air convection system. This arrangement permitted the temperature of brain and skin to be controlled and measured precisely and simultaneously. Results with this sophisticated experimental technique support an additive linear model for the interaction of skin and hypothalamic temperatures in the control of behavioral thermoregulation (31). Significantly, more weight is given to skin versus hypothalamic temperature in the control of behavioral thermoregulation. Therefore, thermal displacements at the skin initiate behaviors which result in escape from ambient temperatures that would otherwise trigger physiological responses with high energy costs.

The effects of hypothalamic lesions on behavioral thermoregulation have been studied (121, 122). It was found that preoptic-anterior hypothalamic area lesions which impair physiological responses to cold or heat stress did not impair behavioral thermoregulation (121). Briefly, these brain-damaged rats did maintain body temperature in the cold by bar-pressing for heat. In another study, however, it was found that bilateral destruction of the classical lateral hypothalamic feeding area abolished behavioral thermoregulation against the cold (122). It is interesting that the brain-damaged rats were not impaired in their physiological response against the cold. Recovery of behavioral thermoregulation in these animals eventually occurred, approximately 40 days postoperative, but was not correlated with recovery from the typical aphagia and adipsia produced by the hypothalamic lesions. Therefore the deficit in behavioral thermoregulation must be added to the list of behavioral disturbances associated with destruction of the lateral hypothalamic area. It is also worth noting in this context that species differences might be important in the neural mechanisms controlling thermoregulation. Extensive preoptic-anterior hypothalamic lesions in the bat did not significantly impair physiological thermoregulatory responses to heat and cold (79).

In addition to the behavioral contributions to thermoregulation, the behavioral effects of ambient temperature on food and water intake have been studied. It has been reported that operant performance of rats on a fixed ratio schedule of food or water reinforcement was reduced as ambient temperature was increased from 25°C up to 30°C (12). In satiated rats, however, a graded increased water intake occurs, within the first 60 minutes of a 300-minute exposure, as a function of ambient temperature of 22°C up to 40°C (60). The observed thermogenic drinking was small and generally less than 1 cc in 60 minutes. Also, the temperature of the water was unspecified. Increased ambient temperature has been shown to affect gastric secretion and food intake in the rat (152). Both food intake and gastric secretion were found to vary inversely with ambient temperature. In view of these inhibitory effects of elevated ambient temperature on food intake, it is surprising to find that direct heating of the preoptic-anterior hypothalamic area increased food intake but decreased water intake (67). Since it was noted that hypothalamic heating decreased core temperature, it appears likely that the decreased core temperature activated ingestive behavior appriate for defense against a decreased core temperature.

WATER DRINKING

A substantial number of recent studies in the area of water deprivation were concerned with specifying the contributions of increased plasma osmolality and decreased plasma volume to drinking. Much of this work can be found in a recent review (50). However, two studies (4, 5) which raise serious questions concerning the procedures used to manipulate blood volume independent of osmolality will be mentioned. Two standard procedures were employed in these experiments to decrease plasma volume—hemorrhage, and hyperoncotic colloid dialysis. In place of the usual measures of plasma osmolality and volume obtained at some fixed, relatively long period after administration of one of these two treatments, determinations were made at the time drinking was initiated. The initiation of drinking following hemorrhage was accompanied by an increase in plasma osmolality. On the other hand, the initiation of drinking following hyperoncotic colloid dialysis was associated with an increased plasma volume but osmolality did not change. It was suggested that this hypervolemia might be attributed to an increased oncotic pressure which increased plasma volume by withdrawing water from cells. Therefore, these two studies indicate that cellular dehydration rather than hypovolemia might be the critical stimulus for initiating drinking behavior following physiological manipulations designed to produce hypovolemic drinking.

Angiotensin, an octapeptide derived from renin, is a potent aviolar constrictor which has attracted considerable attention as a possible dipsogenic hormone (47). Angiotensin injected directly into the preoptic area of the rat evokes rapid and substantial drinking. From a large number of injections in different rats, it was calculated that the threshold for the angiotensin drinking response was approximately 5 ng. However, the effects of the injections below 100 ng were quite variable. In a closely related study using the same intracerebral injection technique, renin was found to elicit drinking with a slower onset but longer duration than angiotensin (51). Injections of kallikrein, bradykinin, vasopressin, oxytocin, or adenosine 3′,5′cyclic phosphate did not affect drinking. Phentolamine, an alpha adrenergic antagonist, blocked intraventricular angiotensin elicited drinking and pressor responses without obvious sedation or motoric disturbances (127). Beta adrenergic blockers, it is important to note, were without effect. Consistent with elicitation of drinking, intracarotid and intraventricular infusions of angiotensin were found to evoke a release of antidiuretic hormone (ADH) (18, 34, 101, 126).

Significantly, intracarotid infusions of angiotensin were more effective in evoking ADH release than equivalent intravenous infusions although both routes of infusion had equivalent effects on blood pressure. In addition, intraventricular infusions of as little as 0.3 ng angiotensin evoked ADH release. It is worth noting that this dose of angiotensin is well below the threshold and the amount required to evoke drinking from the preoptic area. Both drinking and antidiuresis followed intraventricular infusions of angiotensin in the goat (6). Also, intraventricular infusions of angiotensin and NaCl acted synergistically to enhance drinking. It was suggested that the interactive effects of angiotensin and NaCl were due to angiotensin accelerating the intracellular uptake of sodium.

Although it appears that intracerebral injections of angiotensin are dipsogenic, the role of angiotensin in drinking exhibited by the intact animal has not been established. An apparent stumbling block in the consideration of the renin-angiotensin system directly in brain-mediated drinking and water conservation is the problem of blood-brain barrier penetration by these peptides. In an attempt to answer this question, labeled angiotensin II was systemically administered to mice (143). Although high doses resulted in the appearance of labeled angiotensin in cerebral spinal fluid and the lining of the third ventricle, it is possible that the effect can be attributed to a vascular breakdown. In the dog brain, however, renin and an angiotensin forming enzyme was detected 12 days after nephrectomy which suggests that the brain might produce angiotensin (54, 55). Even if the brain produces angiotensin, its storage and release in response to some form of dehydration is far from a resolved issue.

As is well known, bilateral destruction of the lateral hypothalamus results in an animal which never drinks water in response to cellular dehydration. Recently, it was reported (14) that bilateral lesions of the preoptic area sharply attenuate an animal's intake of water in response to hyperoncotic colloid dialysis but has no effect on the animal's intake of water in response to a hypertonic injection of sodium chloride. These results suggest a neuroanatomical separation of brain areas which mediate drinking in response to hypovolemia versus cellular dehydration. Brain injuries which result in a hyperdipsia have also been studied. The septal forebrain area has been a region of particular interest since there is some evidence that the hyperdipsia which follows septal destruction is not secondary to an impairment in water retention mechanisms (90). Rats with septal lesions are hyperdipsic in response to hyperoncotic colloidal dialysis but not to hyperosmotic injections of sodium chloride (15). Furthermore, hyperdipsic rats with septal lesions have a decreased brain content of acetylcholine (134). These results indicate that the septum has a cholinergic inhibitory influence on hypovolemic drinking. A number of other studies have been conducted on the effects of septal lesions on intakes of fluids flavored with saccharin or quinine (23, 41). In general these studies found that rats with septal lesions appear to exhibit drinking of fluids which is similar to the finicky ingestion of food by rats with lesions of the ventromedial hypothalamus (VMH). Therefore, the septum might be the counterpart of the VMH for drinking behavior.

FOOD INGESTION

Blood glucose levels and utilization rates continue to be studied as physiological signals evoking food intake. A nonmetabolized glucose analog, 2-deoxy-D-glucose (2DG) has been utilized as a tool in several of these studies since it decreases cellular availability of glucose without lowering plasma glucose levels. Although the glucose "privation" effect of 2DG has been previously shown by several investigators to induce eating, in a recent study the amount ingested following systemic administration of 2DG was found to be dependent on the animal's deprivation state (71). The effects of 2DG on two feeding patterns were studied in rabbits. If rabbits were fed once daily for 6 hours, subcutaneous injections of 2DG did not reliably affect food intake. When feeding was on an ad libitum basis, however, 2DG injections increased food intake (up to 1.9 times) during a 6-hour feeding period. Apparently, 2DG is effective only in satiated rabbits. Also, since there is some evidence that glucose sensitive cells might exist in the lateral hypothalamus (114), the effects of injecting 2DG directly into LH via chronically implanted cannula have been studied. Intracerebral application of 2DG produced a small but statistically reliable increase in food intake (10). With intracerebral administration of 2DG, however, increased eating was observed under conditions of food deprivation as well as satiety. Also, 2DG injected into LH evoked a prompt and sustained secretion of acid by the stomach at a rate comparable to that produced by insulin hypoglycemia (25). Systemic injections of 2DG did not produce eating in recovered lateral hypothalamic lesioned rats in doses which elicited feeding in intact rats (148). While these recent findings generally supported the idea of a glucostatic monitoring mechanism for regulating food intake located in the hypothalamus, the relatively small amount of eating observed in response to such severe glucose privation necessitates that the effects of 2DG be interpreted with considerable caution.

Gold thioglucose is another glucose analog which has been of considerable interest because of its selective toxic effects on cells of the ventromedial hypothalamus of mice. The site of action of gold thioglucose within the VMH has been studied (37, 38). It was observed that a distinct uptake of gold thioglucose occurred first in the oligodendroglial cells and they degenerated within 6 hours. Twenty-four hours later the neuropil of the VMH also degenerated. Therefore, the damaging effects of gold thioglucose on the VMH are a consequence of glial cell destruction rather than a direct action on nerve cells. Manipulations with gold thioglucose were also studied in diabetic mice which are not normally affected by gold thioglucose (36). Application of insulin to the VMH of diabetic mice made the VMH sensitive to the destructive action of systemically injected gold thioglucose. This result is important because it suggests that the VMH is sensitive to insulin and supports a glucostatic interpretation of feeding.

Although the effects of glucose analogs provide some support for a glucostatic control of food intake, more direct evidence is required. The effects of glucose on hypothalamic unit activity were studied in the medial and lateral areas of deafferented cats (24). Unit activity was found to increase in the medial hypothalamus after intravenous injections of glucose and to decrease after similar injections of insulin. The results obtained for the lateral hypothalamus were inversely related. Unfortunately, metabolic studies do not provide such convincing support for a glucostatic control of eating. For example, the level of blood glucose availability was not found to be closely correlated with food consumption in the normal feeding patterns of rats (84, 85). In the 24-hour eating pattern of rats, a 12-hour hyperphagic-lipogenesis cycle in the dark, and a 12-hour hypophagic-lypolytic cycle in the light was observed. Significantly, low glucose availability was found during the lypolytic and hypophagic cycle; a result which does not support a glucostatic control of eating. Furthermore, in monkeys it has been found that high levels of glucose and glucose utilization are not sufficiently strong satiety factors to reduce food intake when the monkeys are fed on a single daily meal regimen (8). However, it was also noted that gastrointestinal glucose levels had potent satiety effects when associated with oral feeding so the site of glucose entry might be an important signal for the satiety system. Oral factors alone have also been considered significant satiety signals (84). In humans, changes in affective judgment of gustatory and olfactory stimuli occur when fasting subjects are satiated by injections of glucose (20). Sweet substances which are judged as highly pleasant under fasting conditions are judged as unpalatable under conditions of satiety. However, when rats were fed intragastrically according to their normal meal pattern, additional daily oral intake was very slight (118). Therefore, while oral signals are very important, they do not appear to be necessary for satiety, at least in the rat.

Serum osmolality is another important factor in controlling food intake. It is well known that food intake is decreased in water-deprived rats. In an attempt to assess the significance of plasma osmolality changes associated with decreased food intake, the osmolality of a solution water-deprived rats drank immediately prior to eating was varied. As expected, the latency to eat increased as the osmolality of the solution increased (75), and plasma osmolality increased as the osmolality of the solution increased. Similarly, it was found that bar-pressing response rates of water-deprived rats for food on continuous reinforcement (CRF) and variable reinforcement (VI) were an increasing function of the amount of water drunk before testing (0–15 ml) and a decreasing function of the concentration of sodium chloride (NaCl) solutions drunk (.075–.3 *M*) (142). Bar-pressing rates on the VI schedule which generated relatively few food reinforcements were highly correlated with the amount of water and concentration of the saline solutions ingested prior to testing. The latter result is significant because it demonstrates that effects of osmolality are not limited simply to ingestion itself. Under ad libitum conditions, however, varying the osmolality of solutions has little effect on food intake. The effects of equiosmotic intubations twice daily of 45% glucose and 8.1% NaCl at 2% of body weight on 24-hr food intake of rats have been reported (156). Glucose markedly decreased food intake and induced a slight increase of serum osmolality, whereas NaCl had only a slight effect on food intake despite inducing large increases in serum osmolality. The ad libitum food intake of rats remained constant when given noncaloric saccharin or saline solutions to drink (72). Although these solutions differed markedly in terms of osmolality and taste, there were no effects on eating.

The Lateral Hypothalamic Syndrome

The devasting effects of bilateral lesions in the lateral hypothalamus (LH) on ingestive behavior has continued to be a subject of considerable interest. It is not surprising that the simple conception that lesions in this area destroy an "eating" center has been challenged. A relatively new notion is that bilateral LH destruction lowers an animal's body weight set point (117). From this point of view, the anorexia evident following the LH lesions is not simply a loss of readiness to eat but occurs because the preoperative body weight is well above the new lower postoperative body weight set point. In support of a set point interpretation, it has been reported that rats starved preoperatively to below their expected postoperative body weight set point and then subjected to bilateral LH lesions eat immediately postoperatively and increase body weight to a somewhat higher level which is then maintained. Once a new body weight level is achieved postoperatively by LH lesioned rats, it is precisely defended. While this set point interpretation does not offer a comprehensive explanation of all facts of the LH syndrome, it has suggested several interesting experiments and might prove to account satisfactorily for a part of the LH syndrome.

Also, an ontogenetic explanation of the LH syndrome has been offered recently which is based on observations of the development of feeding in thyroid deficient rat pups. The slowdown in the rate of development produced by the thyroid deficiency revealed that these rats go through the same stages of eating behavior as had been previously observed in adult rats subjected to bilateral LH lesions (138). Normal rat pups presumably go through these same stages of development but the rate is so fast that it is difficult to observe. However, it is interesting that normal rat pups in making the transition from maternal milk to dry food and water go through a prolonged period of prandial drinking before the typical adult eating and drinking pattern is acquired (78). Therefore, the fact that the adult LH lesioned rat never progresses beyond the stage of prandial drinking appears understandable in view of the difficulty the normal rat has in progressing through the prandial drinking stage of eating behavior. However, since partial recovery of eating in LH rats can occur without postoperative experience with food ingestion, provided that the animal had preoperative experience with the particular food, the result is difficult to reconcile with an ontogenetic point of view (40). While the ontogenetic concept is provocative, it will require considerable skill to unravel maturational and tissue repair variables from learning processes in understanding ontogenetic development and recovery of function.

Although eating has been the primary object of study in animals sustaining LH ablations, recent studies have broadened the behavioral basis of the disturbances produced by LH lesions. First, LH damage in the rat is accompanied by a severe impairment of escape and avoidance behavior (9, 112). Since pair-fed controls were unaffected in one of these studies, general debilitation is an unlikely explanation of the deficit (9). Also, severe impairments in avoidance behavior occur in rats with parasaggital knife cuts through the medial border of the lateral hypothalamus, a result which cannot be attributed to brain injury per se since improved avoidance behavior was found if the knife cuts were made lateral to LH and involved the internal capsule (64). Furthermore, rats with LH lesions also suffer from impaired behavioral thermoregulation (122). Dogs subjected to LH lesions exhibited a marked change in temperment in addition to the expected anorexia (120). Lively, energetic, social dogs became apathetic, indifferent, and asocial following LH lesions.

In contrast to these reports of impaired performance following LH lesions, LH recovered rats were found to eat sooner in a novel environment and learned a food reinforced discrimination task faster than controls (39). No plausible explanation has been offered for this apparent inconsistency. Two possible significant factors are the lengths of the postoperative recovery period and type of reinforcement. It should also be pointed out that the LH rats were at 70 percent of their preoperative body weight when placed on the food deprivation regimen. Whatever the critical difference might be between these studies, the important point is that recovered LH lesioned rats can respond and learn with food used for reinforcement as efficiently as intact animals.

Most of the literature concerned with the effects of LH injury is based upon the use of bilateral electrolytic lesions. In the past 2 years several different surgical procedures have been utilized. The effects of unilateral electrolytic LH lesions have been investigated thoroughly. A brief aphagia and adipsia followed by a hypophagia and hypodipsia can persist for at least 30 days after unilateral LH lesions (61, 145). Small far lateral LH lesions were more effective in producing anorexia than larger lesions which extended medially into the fornix (145). Furthermore, the far lateral lesioned rats did not eat in response to insulin or drink water overnight when food deprived. These animals did drink normally in response to a hypertonic sodium chloride load. The larger combined far and mid-lateral lesion only resulted in a mild attenuation of overnight water intake without food available but did not affect the response to insulin or hypertonic salt loads. These results might be explained in terms of the removal of an inhibitory influence of the ventromedial hypothalamic inputs to remaining lateral hypothalamic tissue. A similar effect can be observed when the hypothalamus is surgically isolated. Eating in rats with extensive hypothalamic islands, including a major part of the lateral hypothalamus, was less impaired than in animals with small discrete LH electrolytic lesions (42). Once again it is possible that the removal of a presumed inhibitory influence of the medial hypothalamus attenuates the effects of lateral hypothalamic damage. Complete surgical isolation of the hypothalamus, however, resulted in a long-term aphagia and adipsia. Therefore, extensive but incomplete surgical isolation of the hypothalamus had only a slight effect on eating but complete isolation resulted in prolonged aphagia and adipsia. Neuroanatomically, the difference might be attributed to destruction of the far lateral border of the hypothalamus in the complete island preparation. It should be noted that a decrease in general arousal was produced by this complete circumsection of the hypothalamus (42).

The critical importance of the far lateral border of the hypothalamus for eating was supported by the studies in which parasaggital knife cuts were made at different medial versus lateral placements in the lateral hypothalamus (65). Parasaggital cuts between the fornix and LH had a biphasic effect, an initial period of aphagia and adipsia followed by hyperphagia. Cuts made along the lateral border of the hypothalamus resulted in long-term aphagia and adipsia. Similar cuts lateral to the lateral border, however, produced a less severe aphagia and adipsia. In addition to reaffirming the critical importance of damage to the lateral border of the hypothalamus for severe feeding deficits, these results indicate that the significant fiber pathways must turn sharply in this region since the fine knife cuts damage few cells or fibers oriented in the same plane as the knife cuts.

The possible significance of damage to the striatal-pallidal system for the severe effects produced by far lateral hypothalamic lesions was supported by reports of aphagia and adipsia in rats sustaining pallidal lesions (86). In addition, electrical stimulation of the striatal-pallidal produced chewing movements as well as contralateral turning and limb movements but coordinated ingestive behavior did not occur. However, in another study eating and drinking was elicited during electrical stimulation of extra pyramidal fiber systems which lie adjacent to the lateral hypothalamus (111). Total decortication in the rat produced only slight disturbances in eating, if the striatum and palladium remained intact, but invasion of these latter structures by the lesions severely impaired feeding behavior (133).

Results from recent pharmacological lesion techniques have offered new insights into the striatal systems critical for eating behavior (140). Bilateral selective degeneration of the nigral-striatal dopamine (DA) system by intracerebral injections of 6-hydroxydopamine (6-OH-DA) at various points along this system, including the level of the lateral hypothalamus, resulted in a prolonged aphagia and adipsia. Comparable injections of 6-OH-DA at more medial locations which produced selective degeneration in the hypothalamic noradrenergic system did not affect eating. These results indicate that the severe effects of LH lesions might be attributable to the interruption of the nigral-striatal dopamine system. Consequently, it might be more accurate to label these classical disturbances in eating behavior as the nigral-striatal syndrome. Obviously, before accepting such a conclusion more experiments are required in which typical LH lesion effects are compared directly with the effects of nigrostriatal degeneration utilizing more detailed behavior evaluation procedures.

HYPERPHAGIA-OBESITY SYNDROME FOLLOWING VENTROMEDIAL HYPOTHALAMIC INJURY

The well-known hyperphagia-obesity syndrome resulting from ventromedial hypothalamic (VMH) damage continues to be studied intensively. VMH rats decrease food consumption in response to stomach loads of fats, carbohydrates, and protein but fail to increase eating in response to food deprivation (115, 116). VMH rats do not increase eating in a 1-hour food availability period with increasing length of food deprivation. Furthermore, VMH rats do not exhibit a compensatory increase in food intake over a period of days during which food availability is restricted to 1 hour per day and consequently eat substantially less food than normals. However, when returned to an ad libitum schedule the VMH rats overeat and become obese. On the basis of these findings, it was suggested that VMH lesions decrease the ability of an animal to adjust appropriately its food intake to account for depletion or repletion of bodily nutrient stores while leaving intact the response to postprandial satiety.

While these studies provoke new questions regarding the nature of the deficit underlying VMH obesity, some resolution appears to have been achieved on neuroanatomical and hormonal aspects of VMH obesity. Bilateral parasaggital knife cuts immediately lateral to the VMH were shown to be sufficient to produce obesity (3, 58). Bilateral knife cuts, however, produced obesity to a lesser degree than bilateral electrolytic destruction of the VMH (3). The results of these experiments appear consistent with neuroanatomical and electrophysiological suggestions of a lateral orientation of VMH fibers into the lateral hypothalamus. Bilateral destruction of the VMH, however, results in a number of behavioral changes in addition to obesity. Direct comparisons were made of the effects of bilateral knife cuts on several behavioral variables associated with VMH injury including obesity, finickiness, hyperirritability, decreased wood gnawing, and disruption of wheel running and estrous cycles (123). While knife cuts never produced the full constellation of changes associated with bilateral electrolytic destruction of the VMH, transections lateral to the VMH which extended into the anterior hypothalamus produced behavioral changes which most closely approximated the effects of electrolytic destruction. Surprisingly, transections limited to the region between the VMH and LH did not alter feeding behavior but only affected reactivity and wood gnawing. The results of this detailed study suggest a new and more complex neuroanatomical relationship between VMH and LH.

Two hormonal systems known to be affected by VMH lesions which also have a significant role in body weight are insulin and sex hormones. The basis for reported sex differences in the effects of VMH lesions on obesity appears resolved (32). The reason why obesity can more easily be observed in VMH female rats can be explained in terms of the lower body weight of females. When the males and females are equated for body weight, Gold (59) showed that "males get just as fat as females." Changes in insulin levels following VMH lesions remain an important unresolved issue. Blood glucose and insulin were monitored in unrestrained hyperphagic VMH damaged rats and controls (136). Blood glucose levels were similar for VMH and control groups but plasma insulin was substantially higher in the VMH group. These results were evident under both ad libitum and fasting conditions. While this study demonstrated a hyperinsulinemia in rats with VMH lesions, the question arises as to whether the increased insulin is secondary to the increased food intake. In order to answer this question, comparisons were made between blood glucose and insulin levels in hypophysectomized VMH lesioned rats with nonlesioned hypophysectomized controls (68). Both groups were tube fed equally for 28 days. The VMH rats had elevated blood glucose and insulin. Therefore hyperphagia and pituitary function are not necessary for the hyperinsulinemia which occurs after VMH lesions. Whether the VMH lesion exerts its effect through an increased neural activation of pancreatic islets or through a slower gut clearance with increased secretion and gastric production needs to be resolved.

NORADRENERGIC AND CHOLINERGIC CONTROL OF INGESTIVE BEHAVIOR AND BEHAVIOR THERMOREGULATION

There has been considerable interest in specifying possible noradrenergic and cholinergic brain circuits underlying ingestive behavior (62, 98). In the past 2 years two fundamental issues have been raised in a number of studies. One question has been whether food or water intake evoked by chemical stimulation of the brain is similar to that which occurs following deprivation or some other appropriate physiological manipulation. The second fundamental issue concerning the elicitation of intake by intracerebral injections is the question of localization.

In research on the first question, the intraction of carbachol versus water-deprivation-induced drinking has been studied (82). Water deprivation combined with carbachol injections produced more drinking than either treatment alone but less than expected on the basis of simple additivity. Centrally administered atropine blocked carbachol drinking but had little effect on deprivation drinking independent of the level of deprivation. Furthermore, doses of centrally administered atropine which blocked carbachol drinking failed to diminish drinking in response to hypertonic sodium chloride loads (87). Also, carbachol drinking and hypertonic saline load induced drinking were not additive. Bilateral intracerebral injections of atropine sulfate into the lateral preoptic or hypothalamic areas failed to inhibit drinking induced either by systemic injections of renin or by cellular dehydration. Other differences between derprivation versus carbachol-induced drinking under several drinking conditions have been noted (13). It was found that injections of carbachol into the lateral preoptic area produced lower performance rates than water deprivation when water was offered on a variable interval (VI) schedule. Both licking and bar-pressing responses for water were less for carbachol as compared with water deprivation when VI schedules were used (53). In addition, tolerance for the addition of quinine to water was much less for drinking induced by carbachol.

In a similar study, differences were demonstrated between eating induced by norepinephrine and that induced by food deprivation (29). Norepinephrine versus saline injections into the lateral hypothalamus at 0 and 24 hours of food deprivation were compared. At 0 hours, norepinephrine always produced more eating than saline, but at 24 hours norepinephrine produced more eating only when food was available ad libitum. When bar-pressing on a continuous reinforcement schedule was required, there was no difference between norepinephrine and saline injections. When bar-pressing on a VI schedule was required, norepinephrine depressed performance relative to saline injections. As emphasized by these investigators, the eating produced by norepinephrine injections is similar to the eating observed after VMH ablations. It seems apparent then that it is overly simplistic to assume that chemical injections into the brain which elicit eating represent activation of neural systems activated as a result of deprivation. The complexity of the system is increased further by the report that norepinephrine and carbachol might evoke thermogenic responses (7). Utilizing standard intracerebral infusion techniques, the effects of carbachol and norepinephrine on eating, drinking, and body temperature have been studied. It was found that carbachol injections which produced drinking evoked hyperthermia and norepinephrine infusions eliciting eating evoked hypothermia. This result suggests that carbachol drinking and norepinephrine eating might be secondary to thermogenic effects.

The question of where intracerebral chemical injections take their effect has received considerable attention in view of some reports that intraventricular infusions of carbachol can evoke drinking and norepinephrine can evoke eating. Carbachol injected into the lateral ventricle of rats was reported to increase water intake in satiated and water-deprived rats and injections of norepinephrine to elicit eating (131). Therefore, chemicals which have been injected directly into brain tissue might exert their influence as a result of diffusion into the ventricles. The latter possibility questions the localization of effects of chemical injections in specific brain structures since, if diffusion into the ventricles were critical, the effects could be mediated at structures far removed from the injection site. To evaluate directly such a possibility, the effects of injections of 1.0 μl of either radioactive acetylcholine, serotonin, or norepinephrine into the lateral hypothalamus of rats were studied (102). It was found that 35–40 minutes after an injection the radioactive chemical remained localized at the site of the injection and that only a small amount had reached the ventricle. Also, contrary to a ventricular diffusion interpretation of the effects of carbachol-induced drinking, no differences were found in intake, latency to drink, or thresholds for drinking following carbachol injections in solutions or crystalline form at widely separate sites in the limbic system and at widely different distances from the ventricles (88).

It should also be mentioned that a number of pharmacological studies have been undertaken concerning norepinephrine-elicited eating as to whether alpha or beta receptors are being activated. These results, however, are beyond the scope of this review.

A new and more basic mechanism for eating, drinking, and temperature regulation has been suggested recently (103, 104). Utilizing a sophisticated push-pull cannula system, feeding, drinking, and thermoregulatory behavior can be elicited by altering the extracellular sodium-calcium ratio in specific loci within the hypothalamus. Therefore, ionic balance may be the basic mechanism underlying food, water, and temperature regulatory mechanisms.

As a final comment, after having read several hundred articles in the preparation of a review of this type, we hope that scientists will be more careful and efficient in conducting future research in this field. The scientific impact of many experiments could have been vastly improved by relatively simple means. Some major problems remain unsolved because detailed and comprehensive descriptions and adequate measures of behavior were not carried out; external stimulation such as light-dark cycles, temperature and humidity, and diets have not been standardized or in many instances have not been specified; histological techniques still leave much to be desired, the anatomical evidence when available tends to be presented poorly, and proper controls for the usual massive electrode and cannula tract damage have not been implemented. With increased knowledge the differences between species are becoming more obvious and genetic variables are being appreciated, but few research designs yet include these variables. It is difficult to conceive that solutions to important theoretical issues will be found until these relatively basic methodological deficiencies are overcome.

LITERATURE CITED

1. Adair, E. R., Casby, J. U., Stolwijk, J. A. 1970. Behavioral temperature regulation in the squirrel monkey: Changes induced by shifts in hypothalamic temperature. *J. Comp. Physiol. Psychol.* 72:17–27
2. Adolph, E. F. et al 1947. *Physiology of Man in the Desert.* New York: Interscience. 357 pp.
3. Albert, D. J., Storlien, L. H., Albert, J. G., Mah, C. J. 1971. Obesity following disturbances of the ventromedial hypothalamus: A comparison of lesions, lateral cuts, and anterior cuts, *Physiol. Behav.* 7:135–41
4. Almi, C. R. 1970. Hyperosmolality accompanies hypovolemia, a simple explanation of additivity of stimuli for drinking. *Physiol. Behav.* 5:1021–28
5. Ibid 1971. Hypervolemia at the polyethylene glycol induced onset of drinking. *Physiol. Behav.* 7: 369–73
6. Andersson, B., Eriksson, L. 1971. Conjoint action of sodium and angiotensin on brain mechanisms controlling water and salt balances. *Acta Physiol. Scand.* 81:18–29
7. Avery, D. D. 1971. Intrahypothalamic adrenergic and cholinergic effects on temperature and ingestive behavior in the rat. *Neuropharmacology* 10:753–63
8. Baile, C. A., Zinn, W., Mayer, J. 1971. Feeding behavior of monkeys: Glucose utilization rate and site of glucose entry. *Physiol. Behav.* 6:537–41
9. Balagura, S., Coscina, D. V. 1970. Avoidance and escape behavior of rats with aphagia produced by basal diencephalic lesions. *Physiol. Behav.* 5:651–57
10. Balagura, S., Kanner, M. 1971. Hypothalamic sensitivity to 2-deoxy-D-glucose and glucose: Effects on feeding behavior. *Physiol. Behav.* 7:251–55
11. Balagura, S., Wilcox, R. H., Coscina, D. V. 1969. The effect of diencephalic lesions on food intake and motor activity. *Physiol. Behav.* 4:629–33
12. Barofsky, I., Robinson, S. M., Hurwitz, D. A. 1970. The effect of elevated temperature on food and water reinforced fixed ratio performance. *Physiol. Behav.* 5:1243–48
13. Blass, E. M., Chapman, H. W. 1971. An evaluation of the contribution of cholinergic mechanism to thirst. *Physiol. Behav.* 7:679–86
14. Blass, E. M., Epstein, A. N. 1971. A lateral preoptic osmosensitive zone for thirst in the rat. *J. Comp. Physiol. Psychol.* 76:378–94
15. Blass, E. M., Hanson, D. G. 1970. Primary hyperdipsia in the rat following septal lesions. *J. Comp. Physiol. Psychol.* 70:87–93
16. Blatt, B., Lyon, M. 1968. The interrelationship of forebrain and midbrain structures involved in feeding behavior. *Acta Neurol. Scand.* 44:576–95
17. Bolles, R. C. 1960. Grooming behavior in the rat. *J. Comp. Physiol. Psychol.* 53:306–10
18. Bonjour, J. P., Malvin, R. L. 1970. Stimulation of ADH release by the renin-angiotensin system. *Am. J. Physiol.* 218:1555–59
19. Brooks, C. McC., Ushiyama, J., Lange, G. 1962. Reactions of neurons in or near the supraoptic nuclei. *Am. J. Physiol.* 202:487–90
20. Cabanac, M. 1971. The physiological role of pleasure. *Science* 173:1103–7
21. Campbell, B. A. 1964. Theory and research on the effects of water deprivation on random activity in the rat. In *Thirst in the Regulation of Body Water*, ed. M. J. Wayner, 317–34. New York: Pergamon. 570 pp.
22. Campbell, B. A., Misanin, J. R. 1969. Basic Drives. *Ann. Rev. Psychol.* 20:57–84
23. Carey, R. J. 1971. Quinine and saccharin preference-aversion threshold determinations in rats with septal ablations. *J. Comp. Physiol. Psychol.* 76:316–26
24. Chhina, G. S., Anand, B. K., Singh, B., Rao, P. S. 1971. Effects of glucose on hypothalamic feeding centers in deafferented animals. *Am. J. Physiol.* 221:662–67
25. Colin-Jones, D. G., Himsworth, R. L. 1970. The location of the chemoreceptor controlling gastric acid secretion during hypoglycemia. *J. Physiol.* 206:397–409
26. Collier, G. 1969. Body weight loss as a measure of motivation in hunger

and thirst. *Ann. NY Acad. Sci.* 157:594–609

27. Collier, G., Hirsch, E. 1971. Reinforcing properties of spontaneous activity in the rat. *J. Comp. Physiol. Psychol.* 77:155–60

28. Collins, E. H. 1954. Localization of an experimental hypothalamic and midbrain syndrome simulating sleep. *J. Comp. Neurol.* 100:661–91

29. Coons, E. E., Quartermain, D. 1970. Motivational depression associated with norepinephrine-induced eating from the hypothalamus: Resemblance to the ventromedial hyperphagic syndrome. *Physiol. Behav.* 5:687–92

30. Corbit, J. D. 1970. Behavioral regulation of body temperature. See Ref. 69, 777–801

31. Corbit, J. D. 1970. Behavioral regulation of hypothalamic temperature. *Science* 166:256–57

32. Cox, V. C., Kakolewski, J. W., Valenstein, E. S. 1969. Ventromedial hypothalamic lesions and changes in body weight and food consumption in male and female rats. *J. Comp. Physiol. Psychol.* 67:320–26

33. Cravens, R. W., Renner, K. E. 1970. Conditioned appetitive drive states: Empirical evidence and theoretical status. *Psychol. Bull.* 73:212–20

34. Daniels-Severs, A., Ogden, E., Vernikos-Danellis, J. 1971. Centrally mediated effects of angiotensin II in the unanesthetized rat. *Physiol. Behav.* 7:785–87

35. Davis, R. C. 1958. The domain of homeostasis. *Psychol. Rev.* 65:8–13

36. Debons, A. F., Krimsky, I., From, A. 1970. A direct action of insulin on the hypothalamic satiety center. *Am. J. Physiol.* 219:938–43

37. Ibid. Site of action of gold thioglucose in the hypothalamic satiety center, 1397–1402

38. Ibid. Gold thioglucose induction of obesity: Significance of focal gold deposits in hypothalamus, 1403–08

39. Devenport, L. D., Balagura, S. 1971. Lateral hypothalamus: Reevaluation of function in motivated feeding behavior. *Science* 172:744–46

40. Di Cara, L. V. 1970. Role of postoperative feeding experience in recovery from lateral hypothalamic damage. *J. Comp. Physiol. Psychol.* 72:60–65

41. Donovick, P. J., Burright, R. G., Zuromski, E. 1970. Localization of quinine aversion within the septum, habenula, and interpeduncular nucleus of the rat. *J. Comp. Physiol. Psychol.* 71:376–83

42. Ellison, G. D., Sorenson, C. A., Jacobs, B. L. 1970. Two-feeding syndromes following surgical isolation of the hypothalamus in rats. *J. Comp. Physiol. Psychol.* 70: 173–88

43. Emmers, R. 1959. The effects of brainstem stimulation on hind-leg movements in the hooded rat. *Exp. Neurol.* 1:171–86

44. Emmers, R. 1961. The role of the limbic system in producing modifications of spinal reflexes. *Arch. Ital. Biol.* 99:322–42

45. Emmers, R. 1969. Modulation of the activity of hypothalamic "feeding neurons" by stimulation of the gustatory nucleus of cat thalamus. *The Physiologist* 12:215

46. Epstein, A. N. 1971. Lateral hypothalamic syndrome: Its implications for the physiological psychology of hunger and thirst. *Progr. Physiol. Psychol.* 4:263–317

47. Epstein, A. N., Fitzsimons, J. T., Rolls, B. J. 1970. Drinking induced by injection of angiotensin into the brain of the rat. *J. Physiol.* 210:457–74

48. Falk, J. L. 1971. The nature and determinants of adjunctive behavior. *Physiol. Behav.* 6:577–88

49. Falk, J. L. 1971. Determining changes in vital functions: Ingestion. In *Methods in Psychobiology*, ed. R. D. Myers, 1:301–31. New York: Academic. 331 pp.

50. Fitzsimons, J. T. 1971. Physiology of thirst: A review of the extra neural aspects of the mechanisms of drinking. *Progr. Physiol. Psychol.* 4:119–94

51. Fitzsimons, J. T. 1971. The effect on drinking of peptide precursors and of shorter chain peptide fragments of angiotensin II injected into the rat's diencephalon. *J. Physiol.* 214:295–303

52. Fitzsimons, J. T., LeMagnen, J. 1969. Eating as a regulatory control of drinking in the rat. *J. Comp. Physiol. Psychol.* 67:273–83

53. Franklin, K. B. J., Quartermain, D. 1970. Comparison of the motivational properties of deprivation-induced drinking with drinking elicited by central carbachol stimu-

lation. *J. Comp. Physiol. Psychol.* 71:390–95
54. Ganten, D. et al 1971. Renin in dog brain. *Am. J. Physiol.* 221:1733–37
55. Ganten, D. et al 1971. Angiotensin-forming enzyme in brain tissue. *Science* 173:64–65
56. Gladfelter, W. E., Brobeck, J. R. 1962. Decreased spontaneous locomotor activity in the rat induced by hypothalamic lesions. *Am. J. Physiol.* 203:811–17
57. Gold, R. M. 1967. Aphagia and adipsia following unilateral and bilateral asymmetrical lesions in rats. *Physiol. Behav.* 2:211–20
58. Ibid 1970. Hypothalamic hyperphagia produced by parasaggital knife cuts. 5:23–25
59. Gold, R. M. 1970. Hypothalamic hyperphagia: Males get just as fat as females. *J. Comp. Physiol. Psychol.* 71:347–56
60. Grace, J. E., Stevenson, J. A. F. 1971. Thermogenic drinking in the rat. *Am. J. Physiol.* 220:1009–15
61. Gray, R. H., Everitt, A. V. 1970. Hypophagia and hypodipsia induced by unilateral hypothalamic lesions in the rat. *Am. J. Physiol.* 219:398–402
62. Grossman, S. P. 1962. Direct adrenergic and colinergic stimulation of hypothalamic mechanisms. *Am. J. Physiol.* 202:872–82
63. Grossman, S. P. 1968. The physiological basis of specific and nonspecific motivational processes. In *Nebraska Symposium on Motivation*, ed. W. J. Arnold, 1–46. Lincoln: Univ. Nebraska Press. 337 pp.
64. Grossman, S. P. 1970. Avoidance behavior and aggression in rats with transections of the lateral connections of the medial or lateral hypothalamus. *Physiol. Behav.* 5:1103–8
65. Grossman, S. P., Grossman, L. 1971. Food and water intake in rats with parasagittal knife cuts medial or lateral to the lateral hypothalamus. *J. Comp. Physiol. Psychol.* 74: 148–56
66. Hamilton, C. L. 1969. Problems of refeeding after starvation in the rat. *Ann. NY Acad. Sci.* 157: 1004–17
67. Hamilton, C. L., Ciaccia, P. J. 1971. Hypothalamus, temperature regulation and feeding in the rat. *Am. J. Physiol.* 221:800–7
68. Han, P. W., Frohman, L. A. 1970. Hyperinsulinemia in tube-fed hypophysectomized rats bearing hypothalamic lesions. *Am. J. Physiol.* 219:1632–36
69. Hardy, J. D., Gagge, A. P., Stolwijk, J. A., Eds. 1970. *Physiological and Behavioral Temperature Regulation.* Springfield: Thomas. 944 pp.
70. Hoebel, B. G. 1971. Feeding: Neural control of intake. *Ann. Rev. Physiol.* 33:533–68
71. Houpt, T. R., Hance, H. E. 1971. Stimulation of food intake in the rabbit and rat by inhibition of glucose metabolism with 2-deoxy-D-glucose. *J. Comp. Physiol. Psychol.* 76:395–400
72. Hsiao, S., Pertsulakes, W. 1970. Feeding-drinking interaction:Food rationing and intakes of liquids varying in taste, caloric and osmotic properties. *Physiol. Behav.* 5:1495–97
73. Hutton, R. A., Woods, S. C., Makus, W. L. 1970. Conditioned hypoglycemia: Pseudoconditioning controls. *J. Comp. Physiol. Psychol.* 71:198–201
74. Jansen, J. K. S. 1966. On fusimotor reflex activity. In *Muscular Afferents and Motor Control*, ed. R. Granit, 91–105. New York: Wiley. 466 pp.
75. Kakolewski, J. W., Deaux, E. 1970. Initiation of eating as a function of ingestion of hypo-osmotic solutions. *Am. J. Physiol.* 218:590–95
76. Kawamura, Y., Kasahara, Y., Funakoshi, M. 1970. A possible brain mechanism for rejection behavior to strong salt solution. *Physiol. Behav.* 5:67–74
77. Khavari, K. A., Eisman, E. H. 1971. Some parameters of latent learning and generalized drives. *J. Comp. Physiol. Psychol.* 77:463–69
78. Kissileff, H. R. 1971. Acquisition of prandial drinking in weanling rats and in rats recovering from lateral hypothalamic lesions. *J. Comp. Physiol. Psychol.* 77:97–109
79. Kluger, M. J., Heath, J. E. 1971. The effect of preoptic anterior hypothalamic lesions on thermoregulation in the bat. *Am. J. Physiol.* 221:144–49
80. Koch, S. 1956. Behavior as "intrinsically" regulated: Work notes towards a pre-theory of phenomenon called "motivational." In *Nebraska Symposium on Motivation*, ed. M. R. Jones, 42–86.

Lincoln: Univ. Nebraska Press. 311 pp.

81. Kotlyar, B. I., Yeroshenki, T. 1971. Hypothalamic glucoreceptors: The phenomenon of plasticity. *Physiol. Behav.* 7:609–15
82. Krikstone, B. J., Levitt, R. A. 1970. Interactions between water deprivation and chemical brain stimulation. *J. Comp. Physiol. Psychol.* 71:334–40
83. LeMagnen, J. 1969. Peripheral and systemic actions of food in the caloric regulation of intake. *Ann. NY Acad. Sci.* 157:1126–57
84. LeMagnen, J. 1971. Advances in studies on the physiological control and regulation of food intake. *Progr. Physiol. Psychol.* 4:203–61
85. LeMagnen, J., Devos, M. 1970. Metabolic correlates of the meal onset in the free food intake of rats. *Physiol. Behav.* 5:805–14
86. Levine, M. S., Ferguson, N., Kreinick, C. J., Gustafson, J. W., Schwartzbaum, J. S. 1971. Sensorimotor dysfunctions and aphagia and adipsia following pallidal lesions in rats. *J. Comp. Physiol. Psychol.* 77:282–93
87. Levitt, R. A., Buerger, P. B. 1970. Interactions between cholinergic mechanisms and the salt arousal of drinking. *Learn. Motiv.* 1:297–303
88. Levitt, R. A., White, C. S., Sander, D. M. 1970. Dose-response analysis of carbachol-elicited drinking in the rat limbic system. *J. Comp. Physiol. Psychol.* 72:345–50
89. Lindsley, D. B. 1957. Psychophysiology and motivation. In *Nebraska Symposium on Motivation*, ed. M. R. Jones, 44–105. Lincoln: Univ. Nebraska Press. 430 pp.
90. Lubar, J. F., Schaefer, C. F., Wells, D. G. 1969. The role of the septal area in the regulation of water intake and associated motivational behavior. *Ann. NY Acad. Sci.* 157:875–91
91. Lyon, M., Halpern, M., Mintz, E. 1968. The significance of the mesencephalon for coordinated feeding behavior. *Acta Neurol. Scand.* 44:323–46
92. MacDonnell, M. F., Flynn, J. P. 1966. Sensory control of hypothalamic attack. *Anim. Behav.* 14: 339–405
93. Marshall, J. F., Turner, B. H., Teitelbaum, P. 1971. Sensory neglect produced by lateral hypothalamic damage. *Science* 174:523–25
94. Matthews, T. J. 1971. Thermal motivation in the rat. *J. Comp. Physiol. Psychol.* 74:240–47
95. Mayer, J. 1967. General characteristics of the regulation of food intake. *Handb. Physiol.*, Sect. 6 Alimentary Canal 1:3–9
96. Miles, P. R., Gladfelter, W. E. 1969. Lateral hypothalamus and reflex discharges over ventral roots of rat spinal nerves. *Physiol. Behav.* 4:671–75
97. Miller, N. E. 1961. Analytical studies of drive and reward. *Am. Psychol.* 16: 739–54
98. Miller, N. E. 1965. Chemical coding of behavior in the brain. *Science* 148:328–38
99. Millhouse, O. E. 1969. A Golgi study of the descending medial forebrain bundle. *Brain Res.* 15:341–63
100. Morgane, P. J. 1969. The function of the limbic and rhinic forebrain-limbic midbrain systems and reticular formation in the regulation of food and water intake. *Ann. NY Acad. Sci.* 157:806–48
101. Mouw, D., Bonjour, J. P., Malvin, R. L., Vander, A. 1971. Central action of angiotensin in stimulating ADH release. *Am. J. Physiol.* 220: 239–42
102. Myers, R. D., Tytell, M., Kawa, A., Rudy, T. 1971. Microinjection of ^{3}H-acetylcholine, ^{14}C-serotonin and ^{3}H-norepinephrine into the hypothalamus of the rat: Diffusion into tissues and ventricles. *Physiol. Behav.* 7:743–51
103. Myers, R. D., Veale, W. L. 1970. Body temperature: Possible ionic mechanism in the hypothalamus controlling the set point. *Science* 170:95–97
104. Myers, R. D., Veale, W. L. 1971. Spontaneous feeding in the satiated cat evoked by sodium and calcium ions perfused within the hypothalamus. *Physiol. Behav.* 6:507–12
105. Nicolaidis, S. 1969. Discriminatory responses of hypothalamic osmosensitive units to gustatory stimulation in cats. In *Olfaction and Taste*, ed. C. Pfaffmann, 569–73. New York: Rockefeller Univ. Press. 648 pp.
106. Nicolaidis, S. 1969. Early systemic responses to orogastric stimulation in the regulation of food and water balance: Functional and electro-

physiological data. *Ann. NY Acad. Sci.* 157:1176–1203

107. Nissen, H. W. 1954. The nature of drive as innate determinant of behavioral organization. In *Nebraska Symposium on Motivation*, ed. M. R. Jones, 281–321. Lincoln: Univ. Nebraska Press. 322 pp.
108. Norgren, R. 1970. Gustatory responses in the hypothalamus. *Brain Res.* 21:63–77
109. O'Kelly, L. I. 1963. The psychophysiology of motivation. *Ann. Rev. Psychol.* 14:57–92
110. Olds, J. 1955. Physiological mechanisms of reward. In *Nebraska Symposium on Motivation*, ed. M. R. Jones, 73–139. Lincoln: Univ. Nebraska Press. 274 pp.
111. Olds, J., Allan, W. S., Briese, E. 1971. Differentiation of hypothalamic drive and reward centers. *Am. J. Physiol.* 221:368–75
112. Olds, M. E., Frey, J. H. 1971. Effects of hypothalamic lesions on escape behavior produced by midbrain electric stimulation. *Am. J. Physiol.* 221:8–18
113. Oomura, Y., Ono, T., Ooyama, H. 1970. Inhibitory action of the amygdala on the lateral hypothalamic area in rats. *Nature* 228: 1108–10
114. Oomura, Y., Ono, T., Ooyama, H., Wayner, M. J. 1969. Glucose and osmosensitive neurones of the rat hypothalamus. *Nature* 222:282–84
115. Panksepp, J. 1971. Is satiety mediated by the ventromedial hypothalamus? *Physiol. Behav.* 7:381–84
116. Ibid. A reexamination of the role of the ventromedial hypothalamus in feeding behavior, 385–94
117. Powley, T. L., Keesey, R. E. 1970. Relationship of body weight to the lateral hypothalamic feeding syndrome. *J. Comp. Physiol. Psychol.* 70:25–36
118. Quartermain, D., Kissileff, H., Shapiro, R., Miller, N. E. 1971. Suppression of food intake with intragastric loading: Relation to natural feeding cycle. *Science* 173:941–43
119. Rozin, P., Kalat, J. W. 1971. Specific hungers and poisoning as adaptive specializations of learning. *Psychol. Rev.* 78:459–86
120. Rozkowska, E., Fonberg, E. 1970. The effects of lateral hypothalamic lesions on food intake and instrumental alimentary reflex in dogs. *Acta Neurobiol. Exp.* 30:59–68
121. Satinoff, E., Rutstein, J. 1970. Behavioral thermoregulation in rats with anterior hypothalamic lesions. *J. Comp. Physiol. Psychol.* 71: 77–82
122. Satinoff, E., Shan, S. Y. Y. 1971. Loss of behavioral thermoregulation after lateral hypothalamic lesions in rats. *J. Comp. Physiol. Psychol.* 77:302–12
123. Sclafani, A. 1971. Neural pathways involved in the ventromedial hypothalamic lesion syndrome in the rat. *J. Comp. Physiol. Psychol.* 77:70–96
124. Seligman, M. E. P., Ives, C. E., Amis, H., Mineka, S. 1970. Conditioned drinking and its failure to extinguish: Avoidance, preparedness, or functional autonomy. *J. Comp. Physiol. Psychol.* 71: 411–19
125. Seligman, M. E. P., Mineka, S. 1971. Conditioned drinking produced by procaine, NaCl, and angiotensin. *J. Comp. Physiol. Psychol.* 77:110–21
126. Severs, W. B., Daniels-Severs, A., Summy-Long, J., Radir, G. J. 1971. Effects of centrally administered angiotensin II on salt and water excretion. *Pharmacology* 6: 242–52
127. Severs, W. B., Summy-Long, J., Daniels-Severs, A., Connor, J. D. 1971. Influence of adrenergic blocking drugs on central angiotensin effects. *Pharmacology* 5: 205–14
128. Shapavalov, A. I. 1966. Excitation and inhibition of spinal neurons during supraspinal stimulation. See Ref. 74, 331–48
129. Shimazu, H., Hongo, T., Kubota, K. 1962. Two types of central influences on gamma motor system. *J. Neurophysiol.* 25:309–23
130. Siegel, S., Nettleton, N. 1970. Conditioning of insulin-induced hyperphagia. *J. Comp. Physiol. Psychol.* 72:390–93
131. Singer, G., Lovett, D. 1971. Ventricular modification of drinking and eating behavior. *Physiol. Behav.* 6:23–26
132. Smith, D. A. 1972. Increased perioral responsiveness: A possible explanation for the switching of behavior observed during lateral hypothalamic stimulation. *Physiol. Behav.* In press

133. Sorenson, C. A., Ellison, G. D. 1970. Striatal organization of feeding behavior in the decorticate rat. *Exp. Neurol.* 29:162–74

134. Sorenson, J. P. Jr., Harvey, J. A. 1971. Decreased brain acetylcholine after septal lesions in rats: Correlation with thirst. *Physiol. Behav.* 6:723–25

135. Spatz, C., Jones, S. D. 1971. Starvation anorexia as an explanation of "self starvation" of rats living in activity wheels. *J. Comp. Physiol. Psychol.* 77:313–17

136. Steffens, A. B. 1970. Plasma insulin content in relation to blood glucose level and meal pattern in the normal and hypothalamic hyperphagic rat. *Physiol. Behav.* 5: 147–51

137. Stellar, E. 1960. Drive and motivation. *Handb. Physiol.,* Sect. 1 Neurophysiology, 3:1501–27

138. Teitelbaum, P. 1971. The encephalization of hunger. *Progr. Physiol. Psychol.* 4: 319–50

139. Ungerstedt, U. 1971. Stereotaxic mapping of the monoamine pathways in the rat brain. *Acta Physiol. Scand. Suppl.* 367:1–47

140. Ibid. Adipsia and aphagia after 6-hydroxydopamine induced degeneration of the nigro-striatal dopamine system, 95–122

141. Valenstein, E. S., Cox, V. C., Kakolewski, J. W. 1970. Reexamination of the role of the hypothalamus in motivation. *Psychol. Rev.* 77:16–31

142. Van Hemel, P. E., Myer, J. S. 1970. Control of food-motivated instrumental behavior in water-deprived rats by prior water and saline drinking. *Learn. Motiv.* 1:86–94

143. Volver, L., Loew, G. G. 1971. Penetration of angiotensin II into the brain. *Neuropharmacology* 10: 631–36

144. von Euler, C., Soderberg, U. 1957. The influence of hypothalamic thermoreceptive structures on the EEG and gamma motor activity. *Electroenceph. Clin. Neurophysiol.* 9:391–408

145. Wampler, R. S. 1971. Regulatory deficits in rats following unilateral lesions of the lateral hypothalamus. *J. Comp. Physiol. Psychol.* 75:190–99

146. Wayner, M. J. 1970. Motor control functions of the lateral hypothalamus and adjunctive behavior. *Physiol. Behav.* 5:1319–25

147. Wayner, M. J., Cott, A. 1971. Conditioned drinking and the effects of saccharin on its recovery after lateral hypothalamic lesions. *Physiol. Behav.* 7:201–6

148. Wayner, M. J., Cott, A., Millner, J., Tartaglione, R. 1971. Loss of 2-deoxy-D-glucose induced eating in recovered lateral rats. *Physiol. Behav.* 7:881–84

149. Wayner, M. J., Kahan, S., Stoller, W. 1966. Lateral hypothalamic mediation of spinal reflex facilitation during salt arousal of drinking. *Physiol. Behav.* 1:341–50

150. Weiss, B., Laties, V. G. 1961. Behavioral thermoregulation. *Science* 133:1338–44

151. White, S. D., Wayner, M. J., Cott, A. 1970. Effects of intensity, water deprivation, prior water ingestion and palatability on drinking evoked by lateral hypothalamic electric stimulation. *Physiol. Behav.* 5: 611–19

152. Witty, R. T., Long, J. F. 1970. Effect of ambient temperature on gastric secretion and food intake in the rat. *Am. J. Physiol.* 219:1359–62

153. Wolf, A. V. 1958. *Thirst. Physiology of the Urge to Drink and Problems of Water Lack.* Springfield: Thomas. 536 pp.

154. Wolf, G. 1971. Neural mechanisms for sodium appetite: Hypothalamus positive—hypothalamofugal pathways negative. *Physiol. Behav.* 6:381–89

155. Woods, D. J., Routtenberg, A. 1971. "Self-starvation" in activity wheels: Developmental and chlorpromazine interactions. *J. Comp. Physiol. Psychol.* 76:84–93

156. Yin, T. H., Hamilton, C. L., Brobeck, J. R. 1970. Effect of body fluid disturbance on feeding in the rat. *Am. J. Physiol.* 218:1054–59

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MATHEMATICAL LEARNING THEORY AND THE NEW "MENTAL FORESTRY"[1]

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In the decade or so that constitutes the period of our review,[2] progress toward understanding the processes involved in learning can only be described in terms that sound extravagant. It is our task to consider only one part of this remarkable progress, but in order to put our review in perspective, we begin with a brief sketch of our impression of the current condition of the psychology of learning and cognition.

A little more than 10 years ago, experimental psychologists in the field of learning seemed concerned primarily with changes in the frequency of certain response classes over trials as a function of experimental conditions. Since that time a new psychology of cognition has grown up, at least to the point of adolescence, if not young maturity. While it is important to remember that occasional far-sighted theorists and commentators since James (115) and before have seen clearly that cognition is a complex and worthy subject, it is nonetheless true that the emergent techniques and interests in the study of cognitive processes such as attention, encoding, search strategies, rehearsal processes, and understanding constitute a kind of revolution.[3]

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[2] Mathematical learning theory has not been the topic of an earlier contribution to the *Annual Review*. We date our review mainly from Estes' review of learning theory in 1962 (65), although we have omitted some material dealt with by Millward in 1964 (24), and our review overlaps to some extent Hunt's review of computer simulation in 1968 (108). Our literature review ends with the calendar year 1971.

[3] Though not in the sense of Kuhn (130), whose concept of a revolution seems to us to be quite irrelevant to the analysis of scientific progress. We consider the new developments of the 1960s as completely continuous with the development of mathematical learning theory in the 1950s by many workers, including Estes (59, 62), Bush & Mosteller (37, 38), and Suppes & Atkinson (212), and although we did not participate in those developments, it seems to us that they were quite continuous with earlier well-known work such as that of Hull (106). Virtually all of the work reviewed here has been contributed by scientists trained by those who built psychology during what we and others would call the prerevolutionary period of cognitive psychology, or by those prerevolutionary scientists themselves. In our judgment, what we are reporting is *not* a paradigm shift, whatever that might be.

This revolution has influenced the study of learning very substantially. In particular, learning has been subjected to an analysis of processes such as attention, storage, and retrieval that underlie the overall changes of state that are labeled learning. Major innovations have occurred at levels involving general conceptualization, theoretical method, and experimental technique. Workers in the field are all aware of the new experimental paradigms that have been devised to isolate and examine particular processes, such as sensory storage of briefly exposed visual information (2, 71, 206), attentional and short-term storage processes in audition (34), short-term retention of verbal items (35, 173, 174, 201), encoding processes and the role of similarity (43, 179), processes of retrieval from both short- and long-term memory (42, 133, 148, 209), and the learning of concepts and rules (99, 190), to mention just a few.

Along with these developments in experimental methods, several formal developments have provided increased power for theoretical work. In his review of literature prior to 1962, Estes (65, p. 111) correctly foresaw the importance of developments in mathematics by which "psychologists have had placed in their hands the simple but powerful methods of finite Markov chains," which have provided the formal basis of much substantive analysis. Of similar importance have been continued developments in artificial intelligence, stimulating numerous efforts to understand psychological processes with the aid of computer simulation (110).

The most important theoretical development, in our opinion, has been the evolution of concepts for describing and analyzing psychological processes and structures. A notable feature of many theoretical contributions has been the assumption of considerable structural complexity. The structural properties of systems for processing information and memorizing have been considered in several theories (9, 161). Theorists have assumed a hierarchical process of feature extraction, with elementary properties analyzed initially, and more complex properties or names of stimuli processed or stored at higher levels (137, 197, 199). Models of problem solving have incorporated multilevel functioning, with recursive methods and executive control of processes (58, 184). Tree structures have been proposed to represent what a subject learns when a list of verbal items is memorized (76, 101), and when a classificatory concept has been induced during concept learning (108, 112, 229). And the problem of serial order has been approached with increased sophistication, with representations of sequential concepts as hierarchies of rules or transformations (189, 190, 204, 233).

A decade ago it was still appropriate to characterize the psychology of learning as the study of "mental chemistry," that is, the investigation of processes by which elements combine into more complex compounds. We sense that the study of learning is in a transition stage in which our concerns are moving toward an interest in the processes by which trees and other cognitive structures are acquired and modified. Perhaps "mental forestry" suggests a better analogy for characterizing the current transition stage, if not the final version of the psychology of learning that is emerging. At least, if we are still mental chemists, we are

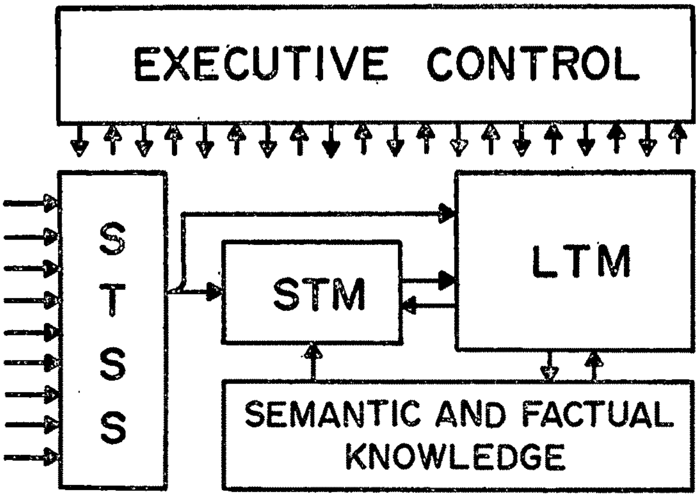

FIGURE 1. Divisions of information-processing function in the human memory system.

dealing with structures comparable to those of organic rather than inorganic compounds.

In the new psychology of cognition that has developed in the last decade or so, it is customary to represent some main divisions of function in a flow diagram, and Figure 1 shows the main components of what we take to be the current consensus. Information enters the system through sensory registers, where it is held in short-term sensory storage (STSS), but is lost very quickly—usually within fractions of a second—unless it is processed further into the system. Most theorists assume that further processing consists of attending to the sensory information in STSS, which has the effect of transferring information to short-term memory (STM). Short-term memory has a relatively small capacity of a few items or chunks of information, and items are apparently stored most frequently if not always in a form appropriate for rehearsal, with phonemic features playing a prominent role. Items are typically held in STM for times on the order of seconds, and retrieval of information from STM is rapid and reliable.

By long-term memory (LTM) we mean to denote a system of relatively large capacity, at least up to dozens of items. Retrieval from LTM is problematic, and it appears that much information apparently lost actually remains in the system but becomes inaccessible. The time scale we have in mind regarding LTM is on the order of a few minutes up to several hours. Examples of learning that involve LTM include memorizing a list of words during an experiment, or retaining information about experimental procedures while reading the results section of a scientific article. By semantic and factual knowledge, we refer to the person's store of knowledge about concepts and past events that is virtually permanent.

Terminology is troublesome here, since several authors have referred to this kind of permanent store as long-term memory, with considerable justification. But we have chosen the usage described here in order to make maximal contact with the existing literature.

Our reference to "executive control" in Figure 1 recognizes the importance of attention and decision processes in the storage, rehearsal, and retrieval of information. A subject may decide to ignore an item in STSS rather than enter it in STM (9). Contact with the lexical contents of semantic and factual knowledge involves a decision rule for determining whether enough information has been perceived to justify assigning a name to the stimulus (137, 197). There are mechanisms for selecting items held in STM for rehearsal (9, 17, 183), and for selecting attributes of stimuli for special attention and processing (40, 185, 239). Developments of organized groupings of items in LTM and strategies of searching in LTM for items (124, 202) are further functions carried out under executive control. When information is retrieved, a decision has to be made whether the information is adequate to justify a response (16, 29, 122, 161).

The learning theories that are the subject of this review deal with the process of acquiring information and remembering it. Using a criterion that is fairly standard, albeit arbitrary, we consider learning as a process resulting in retention of information for at least a few minutes. Thus, in relation to Figure 1, we consider theories dealing with the process of storing and retaining information in LTM. We omit consideration of STSS entirely, and our concern with STM is limited to processes of short-term retention that influence storage of information in LTM. Modifications in the structure of a person's semantic and factual knowledge certainly constitute learning, but rigorous theoretical analyses of such processes have not yet appeared. Another limitation on this review is imposed by the fact that nearly all quantitative theorizing during the last decade has dealt with the storage and retention of verbal information; we therefore have little to say about either animal learning or about the learning of skills. Animal learning has received limited attention by quantitatively oriented theorists during the last decade, and although quantitative analyses have been carried out with respect to the properties of skilled performance, we are aware of very little quantitative theorizing on the acquisition of skills, with Timpe's work (223–225) being the main exception that we know of.

On the question of what constitutes a "mathematical" learning theory, we are neither certain of our criteria, nor do we think, in spite of our efforts, that we have been completely consistent. In general, we have assumed that mathematical theories consist of hypotheses stated in a relatively formal way together with implications drawn from those hypotheses by means of mathematical reasoning. Nearly all of the quantitative theorizing covered by our review employs either probability theory or computer programs as the mathematical basis. But the relative importance of mathematical work in a contribution to theory varies a great deal. We are aware that other reviewers would probably apply quite different criteria for inclusion in this area. Since we are primarily interested in learning theory rather than mathematics, we think we have been quite conservative in excluding "nonmathematical" contributions, but it seems certain that others would include some of the contributions that we have failed to mention.

The remainder of this review presents our impression of the current state of theoretical understanding of learning processes as represented in relatively rigorous (i.e. "mathematical") theories. Our discussion in the next section is organized around the question: What is learned? Our discussion is focused on the problem of representing what is stored during learning, but we also comment briefly on the influence of forgetting and retrieval processes on acquisition and performance. In the third section we review theoretical analyses of specific varieties of learning, and in the final section we close by reviewing some analyses of formal properties and statistical methods.

WHAT IS LEARNED?

As an outcome of learning, information is stored in memory that was not there before, or some structure of knowledge is modified. Theoretical representations of what is stored during learning seem to be of two kinds: either information stored in memory is assumed to consist of representations of the items studied, or the contents of memory are assumed to be a set of rules for generating a response or a series of responses. The difference may be more apparent than real. We suppose that theorists who refer explicitly only to storage of item representations are being elliptical, since it is obvious that there must be some procedure for translating the stored information into responses. On the other hand, theories assuming that rules for response generation can be learned without any concomitant learning of item information tend to overlook the evidence that subjects can often respond correctly on tests that require the retrieval from memory of information about specific items.

ITEM REPRESENTATIONS

Storage.—Theories that assume items rather than rules are stored vary on two dimensions. One dimension is whether items are assumed to exist in memory in a unitary way or are assumed to have a more complex representation, usually involving feature or attribute descriptions. A second dimension is whether the representation in memory is all-or-none or varies in strength along some discrete or continuous scale.

In the simplest combination of assumptions, an item is stored as a unit, and storage is an all-or-none process. This assumption is made in the all-or-none Markov models in which the learning of an item consists of a discrete change in state. The simplest case involves a two-state system in which the only distinction made is whether an item is learned or unlearned (27, 64). To analyze certain kinds of transient effects, a third state has been introduced corresponding to STM. An item may be stored in STM temporarily after study, with some probability of returning to the unlearned state. Entry into the learned state corresponds to achieving a record of the item in LTM (7, 86, 121, 235). Unitary, all-or-none storage is also assumed in analyses based on queuing theory (28, 183), where STM is assumed to consist of a queue of items waiting to be processed, and storage in LTM results when an item is processed, which occurs when the item reaches the first position in the queue. In his fixed-point model, Murdock (153, 154) also assumes all-or-none storage, but whether an item is retrievable or not after a given retention interval is determined by a fluctuation process assumed to reflect the interaction of forgetting and reminiscence.

Another class of theories assumes that storage involves the representation of an item in a unitary way, but that the strength of the representation is a variable. In one version, used by Bernbach (17, 18), storage consists of creating copies of an item, so an item may be represented by any number of copies in memory. In Bernbach's theory there is no separate system of STM, but the probability of adding copies by rehearsal decreases with time after an item's presentations, due to the increasing chance that all the copies of the item have been lost. Another theory that assumes unitary storage with varying strength is Wickelgren's (237) trace theory. Wickelgren assumes that the representation of an item consists of several traces, each varying in strength as a function of time since the item was studied. The several components of the memory system (Wickelgren assumed there are four) are represented by traces with different rates of consolidation and decay. Another variation was given by Atkinson & Shiffrin (9), who assumed that occupancy of STM is all-or-none, with a finite upper limit on the number of items that can be in STM at any time. Storage in LTM is assumed to involve representation of unitary items, but the strength of the representation is a continuous variable referred to as the amount of information in LTM for an item, with the amount of information transferred to LTM being proportional to the amount of time that the item was in STM. The idea that recognition depends on a decision process based on the familiarity or strength of an item's trace also uses the idea of a unitary variable-strength representation (16, 50, 100, 122, 146, 172, 238).

The second main alternative assumption about storage is that the representation of an item is not unitary but consists of a representation of some of its features. The simplest analyses using this idea are the N-element models of stimulus sampling theory (70, 214) where it is assumed that a stimulus situation consists of many elements or presents different potential perceptual patterns. At a specified stage of learning some proportion of the elements or patterns are associated with a given response in the subject's memory; at the limit, if a single response has always been paired with the stimulus, all the elements or patterns of that stimulus are represented in memory in association with the response. The assumptions of the mixed pattern-components model (8, 81, 83) are that all the components of a stimulus are connected with a response in memory, and if a subset of one or more of the original components appears as a test stimulus, the response will be performed. Thus the mixed model includes the implicit assumption that stimulus features or components are represented in memory. In a similar way, Bower's (29) multicomponent theory of the memory trace assumes that a set or vector of stimulus properties is stored in memory. Bower's analysis deals with the process of losing elements from the stored vector through decay or interference during a retention interval and thus differs from the analysis given in stimulus sampling theory, which deals with the process of building a set of stored components during training.

In a sense, the fluctuation model formulated by Estes (60, 61) provides a theory of memory storage that generalizes the two ideas given in ordinary stimulus sampling theory and in Bower's multicomponent analysis, since the fluctuation model considers the process of storing a set of component associations for a stimulus as well as the loss of those components over a retention interval. In the fluctuation model, Estes assumed that a subset of the potential elements for a stimulus are available for association with response in any situation, but over a retention interval the elements in the available subset are exchanged with elements that were unavailable originally, thus causing elements associated with the response in memory to become unavailable at a later test. Elements are not permanently lost in the fluctuation model; they may fluctuate back to the available set at a later time.

In some theories dealing with stimulus features, properties of certain features have been specified. In a theory given by Restle (187) representation of an item initially stored in memory may not be distinctive enough to permit discrimination from similar items. The representation needed includes the feature that distinguishes between similar stimuli or responses. Another theory specifying the nature of features represented in memory was given by Laughery (137), who specified a set of visual and acoustic features for letters and numerals and assumed that these are stored as part of one's permanent knowledge. Laughery's theory, like Bernbach's described above, does not distinguish between STM and LTM as separate systems. In Laughery's analysis, acoustic features of presented items are represented in memory and are updated and strengthened by rehearsal. Another theory that assumes a representation of features in the subject's permanent knowledge was given by Norman & Rumelhart (161). Their theory of storage uses the idea of contextual association; they assume that when an item is recognized in study, its features are tagged in memory showing the context in which it was presented. The information stored in memory according to Norman & Rumelhart's theory consists of associations between features of items and contextual tags. Association between features or properties and responses is the assumed nature of information storage in classical discrimination learning theory of the Hull-spence variety (207, 241). Other kinds of information assumed to be stored about an item include the frequency of its occurrence (20) and the time of its occurrence (202, 203), and the relative position of the item on some quantitative scale such as size (30).

Forgetting.—Forgetting is not a concern of this review except to the extent that it influences acquisition processes. Several different types of interactions between acquisition and forgetting are found among different theory types. In those theories assuming a unidimensional memory trace that varies in strength or number of stored elements, it is natural to assume that forgetting consists of a loss in strength or number of stored elements. After a series of learning trials, performance is determined by the net effect of the acquisition of strength on the learning trials and the loss in strength between learning trials. This interpretation of the interaction between forgetting and acquisition, although quite appealing intuitively, has the considerable defect of being nearly always completely wrong in its predictions of the effects of the temporal spacing of learning trails. Given any reasonable learning operator, such an interaction leads to the prediction that learning is optimized when the spacing between trials is minimized [for a discussion of this issue, see Bjork (23)].

In models in which what is stored can be in more than one memory state, such as STM and LTM, or available and unavailable, the interaction between forgetting and acquisition is more complex. Under some circumstances the interaction can be such that long-term learning profits from short-term forgetting. This kind of interaction can occur in models of the rehearsal-consolidation type (9, 132), of the stimulus fluctuation type (60), and of the multistate Markov type (86). In these theories, increased forgetting between any two learning trials reduces performance at that point in the learning process, but long-term learning may profit from either increased consolidation of long-term memory as the temporal spacing between two learning trials is increased, or from improved long-term acquisition on the second of the two learning trials. Long-term acquisition might be facilitated on the second learning trial in two ways. First, the number of formerly unconditioned and unavailable stimulus elements that become available and conditionable through fluctuation could increase with the temporal spacing between trials. On the other hand, the probability of transition from a forgotten state to long-term memory could exceed the probability of transition from short-term memory to long-term memory, and a longer interval between two learning trials would decrease the likelihood that an item would remain in short-term memory at the time of the second learning trial.

Retrieval.—In the foregoing theories of representational storage, retrieval processes sometimes do and sometimes do not play a major role in determining performance. When an item is assumed to be stored as a unit, there is not much basis for a theory of retrieval, although retrieval probability might be assumed to vary with number of copies stored, or, under the assumption that an item be stored as a unit in one or more different memory states, retrieval of an item might be assumed (89, 243) to vary with its state in memory.

When an item is assumed to be stored in terms of its features or trace strength, there is a natural basis for specifying retrieval mechanisms. Given that a feature list in memory incompletely specifies an item, different assumptions about the retrieval process yield different predictions of both frequency and types of errors on tests of recall and recognition (29, 137, 161). If a memory trace is assumed to vary in strength on a continuum, recall and recognition may be assumed to depend on decision mechanisms, such as that embodied in the theory of signal detectability (238, for example).

When judgments of list membership, recency, or frequency of occurrence are required, retrieval mechanisms play a critical role. There is no reason to expect that the retrieval mechanisms involved in such judgments tend to be simple; it is almost certain that comparisons among items, judgments of strength, relative position in structural organization, and encoded tags and labels are all involved.

Comments on alternative assumptions.—A review of alternative theories inevitably raises the question of which is correct. On the dimension of unitary representation versus representation of features the question is easy to answer. A theory that assumes representation of components or features of stimuli is more general than a theory assuming that each stimulus record is unitary, and several well-known facts about memory indicate that the more detailed assumption is needed in many situations. Any process of selection or variability of encoding must operate on a basis of multicomponent representation of some kind, and the operation of selective and variable processes in encoding seems quite well established. On the other hand, assumption of unitary representation is a useful special case of the more general idea, and can be used to represent the process of learning in many situations where the complicating factors of selection and variable encoding can be neglected.

The issue regarding all-or-none storage versus variable strength in the memory representation is considerably harder to evaluate. Even when unitary representation is assumed, it turns out, as Restle (188) showed, that all the properties of observable performance produced by all-or-none learning can be mimicked by a system in which learning is gradual, performance depends on a threshold, and an appropriate distribution of individual differences exists. This means that a definitive choice in favor or all-or-none learning cannot be made on empirical grounds, since the all-or-none hypothesis is empirically equivalent to a special case of gradual learning. If it is assumed that representation involves features of items, the issue becomes even harder to decide, since even if all-or-none storage of individual features is assumed, the possibility of partial representation implies that learning of items may not be all-or-none in nature. The question of deciding whether representations of individual features are stored in an all-or-none fashion involves the same formal difficulties as apply to that question regarding individual items, except that the decision has to involve several theoretical entities instead of just one.

While a definitive empirical case for the assumption of all-or-none storage seems unattainable, there appear to be strong theoretical and methodological reasons supporting the use of that idea. The main advantage of the all-or-none idea is that it is testable in Popper's (178) sense and therefore can serve as the basis of theoretical advances in which changes in the theory are guided directly by empirical evidence. Thus it continues to seem preferable to view cases in which storage of information appears to occur in a gradual fashion as cases in need of more detailed analysis, as Estes (66) suggested in 1964. This attitude has led to the analysis of several tasks as combinations of all-or-none processes. On the other hand, analyses based on the weaker assumption of gradual changes in strength of representation undoubtedly will continue to provide useful information, and results obtained under the two kinds of assumptions probably can be related to each other in future analyses.

GENERATIVE REPRESENTATIONS

Storage.—In many theories the information stored in memory is in the form of rules for selecting or generating responses, rather than representation of events. The case studied most intensively involves rules for classifying stimuli in concept identification, but considerable analysis has also been given to the structure of sequential concepts, where the stored rule is a means of generating a sequence of responses.

In the case of classification, the outcome of learning is a rule or strategy that assigns a response to each stimulus in the set used in the experiment. There are two questions about what kind of information is stored in memory. First, what is the form in which the rule or strategy is represented? This is the direct question of what is learned in concept identification. The other question is, what kind of information is held in memory during learning? This second question involves issues about the retrieval of information from the store of permanent knowledge as well as the kind of information held in STM for use in processing information.

Regarding the first problem as to the way classification rules are represented, there have been two main assumptions. One assumption is that a concept is stored in the form of a list of properties, along with the name of the concept (116, 184). A second assumption is that the relevant properties of the concept are stored as a rule for making a series of tests and a decision (108, 109). For example, if a subject has learned that the concept GAX refers to the category of large, blue stimuli, the list representation could be in the form "GAX: large, blue," combined with the response rule that all entries on a property list should be matched by a stimulus for the name to be assigned (184). On the other hand, a decision tree for this concept might be:

Test color; if blue, proceed; if not blue, respond "not GAX."

Test size; if large, respond "GAX;" if not, respond "not GAX." The difference is obviously one of notation. The list of properties and an appropriate response rule lead to the same performance as the decision tree. In fact, any decision tree for a concept can be represented as a matrix in which each row is a list of properties (112). In the simplest case of concept identification, involving a single relevant attribute, some theories refer to selection of an attribute and association with a response as separate processes (32), while others refer to the selection of a strategy, which specifies a response for each stimulus in the set being used (185). The difference does not seem to be a substantive one. In more complex situations that require learning to classify patterns that have variable features, theorists have assumed that the importance given to the different features is modified on the basis of information received during learning. Thus the outcome of learning not only involves selection of attributes for testing, but also involves setting weights on the various tests for deciding to which category a presented pattern belongs (151, 200, 230), or in evaluating one's position in a game (198).

The issue as to the kind of information held in memory during processing *does* involve assumptions that differ in a substantive way. In several theories, the subject remembers a set of stimuli and their response assignments, and hypotheses about the concept are selected on the basis of scanning the remembered set of stimuli (45, 111, 116, 152, 227). In other theories, information is held in STM in the form of a list of hypotheses that are being considered (79, 118, 157, 185, 228) and there may also be memory for hypotheses that have been eliminated from past samples (10, 57, 96, 239). Chumbley (40) obtained experimental evidence on the question favoring the idea that it is hypotheses that are stored, rather than representations of stimuli.

Regarding the question of accessing information from permanent storage, nearly all theories have assumed a constant set of descriptors (for the stimulus-representation models) or possible hypotheses (for the hypothesis-list models) used by the subject during learning. When information is taken from permanent storage (usually when the current list of hypotheses is exhausted, or when an error in classification is made) the selection from the set in permanent storage is usually assumed to be random, with fixed probabilities for the various possible hypotheses. One interesting exception is the hypothesis of Falmagne (74, 75), who assumed that the sampling probability of an hypothesis is increased on trials when that hypothesis is consistent with information given, and decreased when it is inconsistent.

The assumption that what is learned is a rule for generating responses, rather than a representation of events, has been postulated in several theories about the learning of lists of verbal materials. One straightforward case involves lists of paired associates that include sets of similar stimuli paired with a single response. These tasks permit the subject to group items and use a rule of the form, "Give response R to stimuli with property P," in a fashion similar to standard concept identification. Theories dealing with this rule-learning aspect of associative learning have been developed. Batchelder (11, 12) developed the idea of a classification rule explicitly in his theory; other investigators have dealt with the problem by postulating various mechanisms of transfer between similar items represented in memory (8, 81–83, 92, 186, 187). Another possibility regarding list learning is that the subject's knowledge about the entire list is acquired in the form of a discrimination net. This idea, proposed by Feigenbaum (76) and used in an extensive study by Hintzman (101), proposes that information about a list is stored in the form of a decision hierarchy with each node of the tree being a test on some attribute of items in the list. The selection of response depends on the outcome of the series of decisions, just as in the analyses of concept identification described above.

Another important use of hierarchical representation of the outcome of learning has been in analysis of serial learning. Feigenbaum & Simon (78) used the idea of a discrimination net to represent the sequential learning that occurs when a person learns a list of words. Analyses of the acquisition of sequential concepts when subjects are shown series of numbers, letters, or patterns of switch settings have been given in a number of investigations (95, 189, 190, 204, 233). The various analyses share important features. A process of encoding relationships between elements is assumed, often involving the formation of units based on short subsequences. Then rules for combining the subunits are acquired, resulting in a hierarchical structure of rules for generating the sequence. Evidence obtained by Bjork (22) suggests the pleasant possibility that in at least some nontrivial cases, storage of components of a hierarchical structure is all-or-none in nature.

Forgetting.—In some generative representations, the structure that must be acquired is complex enough that forgetting can be assumed to influence both performance and the ongoing acquisition of the representation. Very often this is not the case; many of the typical concepts, rules, or structures involved in experiments are simple enough that they do not pose memory problems—for example, a concept such as "Give response R to stimuli that are red" is not difficult to remember. In the case of certain sequential concepts (22), however, and in the case where what is acquired is a tree structure or discrimination net (101), retaining the representation in memory is not trivial and may influence heavily the acquisition of the representation.

Even in those cases where the generative representation to be learned poses no memory problems in itself, the retention of the information content contained in a series of learning trials may constitute a significant memory load. Acquisition in such situations may, therefore, depend on memory in an indirect but critical way; the decisions, tests, and other operations involved in the learning of a generative representation can be effective only to the extent that the item information necessary for learning to take place is retained. The importance of memory for specific items is sometimes nullified procedurally by providing subjects with displays that relieve them of retaining such information (204).

Retrieval.—When what is stored is generative in form, retrieval from memory does not tend to be a problem. Given that a response rule has been learned, retrieving the response is typically straightforward, with two possible exceptions. One exception is in the learning of sequential concepts, in which case generating the series of responses required may be subject to failures of retrieval from memory. A second and more interesting case is the learning of lists of verbal materials by means of the storage of tree structures. In such cases retrieval becomes very important, especially in the case where the structure is incomplete. Both frequency and types of errors are influenced heavily by what is assumed about the tests and decisions involved in the retrieval process.

ANALYSES OF SPECIFIC LEARNING TASKS

The discussion in the preceding section deals with general principles that are postulated in current mathematical theories of learning. Any application of those principles takes the features of a specific learning task into account and specifies the processes of information storage, retention, and retrieval that occur in the situation being analyzed. Of course, the various experimental situations that have been developed for the study of learning provide information about different aspects of the learning process. The theoretical framework that we have adopted, described at the beginning of this review, has consequences for the interpretation we give of results obtained in various experimental settings. Within that framework we now review published analyses of various tasks, and while this kind of review inevitably takes on something of the character of a catalogue, we hope to indicate relationships between these specific analyses and the substantive issues discussed earlier.

LEARNING TO RECOGNIZE

Discrete state models.—When a list of items is shown and later tested for recognition, information about learning is obtained with minimal requirements on the subject for retrieval of information. Kintsch & Morris (125) analyzed multitrial recognition learning of trigrams and obtained data agreeing with the all-or-none learning model. Kintsch (121) and Olson (171) investigated effects of varying intervals between presentations of items during recognition, and obtained results compatible with the all-or-none model, elaborated by the addition of a state representing short-term memory. Although Olson (171) found some evidence that items could be lost from LTM, it is a good approximation to assume that when subjects study items in recognition learning, each trial provides an opportunity for a stable, distinctive representation to be stored in LTM, and failing that, a representation is held in STM for a time.

Analyses based on decision theory.—While performance in multitrial recognition learning has the all-or-none property, an important factor is that subjects give just "yes" or "no" responses in that experiment. When subjects also give confidence ratings about their responses, a more complicated process is involved. Ideas taken from the theory of signal detectability have been used, assuming that the strengths of memory traces or feelings of familiarity vary among items stored in memory, and judgment of confidence indicates the amount of this strength or familiarity. The strengths of new or distractor items have a distribution analogous to the distribution of likelihood ratios on noise trails in detection. In analyses by Parks (172) and by Wickelgren & Norman (238) strengths of presented items are greater, on the average, and the amount by which the mean strength of presented items exceeds the mean of the distractor distribution depends on the time since presentation.

Freund, Loftus & Atkinson (80) analyzed recognition performance on number-letter pairs, using Atkinson & Shiffrin's (9) model of the storage of information about items in memory. The model includes an assumption that the amount of information stored is proportional to the time an item resides in STM, and the amount lost is proportional to the time elapsed between storage and test. Two alternative assumptions about retrieval were compared. It appeared preferable to assume that the amount of information determined a value of d' for a decision process like that used in the theory of signal detectability rather than to assume all-or-none retrieval of items with the probability of retrieval determined by the amount of information retained. Donaldson & Glathe (50) also discussed application of detectability theory to analysis of recognition and recall, especially regarding interpretation of the value of d' obtained in recall performance.

In analyses by Bernbach (16, 19) and Kintsch (122) a single distribution of strengths associated with items with stored representations is assumed. An item that has been presented has some probability of being stored, and as other items are presented and tested there is a possibility that the stored representation is lost. Thus in this analysis some of the presented items have strength taken from the distribution of stored items, and others come from the same distribution as new items. Kintsch's (122) analysis adds the feature that if an item's stored representation is sufficiently strong, it will not drop down into the initial distribution—in other words, it enters the learned state of the Markov model of learning.

Analyses assuming storage of features.—Further analyses of recognition have been provided, based on the idea that an item's representation in memory is a partial list of features. In his presentation of the multicomponent model, Bower (29) gave analyses of several kinds of recognition experiments, using the idea that some features of an item's representation are lost during a retention interval. Response on a recognition test depends on the number of features of a test item that match features retained in memory, relative to a criterion that the subject has, or compared with the number of matching features of other items presented. A related analysis given by Norman & Rumelhart (161) assumes that storage consists of tagging features of the studied item with context information. During a retention interval in which other items are presented, some of the tags of an item's features are tagged by new contexts and this produces uncertainty about the item when it is tested. In a test of recognition, the features of the tested item are scanned, and response depends on the number of features found with appropriate context tags.

Simulations of recognition.—Computer simulations of pattern recognition have provided important contributions to theory about the processes involved in learning to recognize. Hunt's (110) review presents a recent summary of the main ideas. Two hypotheses are particularly interesting for the theory of learning. One is that learning to recognize a character involves storing the features of each character presented during learning and computing the probability that a given feature comes from each character in the practice set. These probabilities are used when a test character is presented to make a decision about which character is being shown (200). A second idea is that characteristics consisting of local patterns are stored as a feature list for each character that can be recognized. Recognition involves an effort to match the stored characteristics with features of the presented character, and experience with known characters leads to adjustment in the weights given to the various characteristics in the decision about what character is being shown (230). General discussions of pattern recognizing systems and their learning capabilities have been given by Nilsson (159) and by Minsky & Papert (151).

LEARNING TO RETRIEVE LISTS

Free-recall memorizing.—Analyses of performance in free-recall memorizing by Kintsch & Morris (125) and by Waugh & Smith (236) have shown that memorizing items for recall is not all-or-none in nature, and that a two-stage Markov model gives an acceptable account of the data. After recognition pretraining, recall memorizing was an all-or-none process, suggesting that the whole process of memorizing for recall involves a first stage of storing a representation of the item, followed by a stage of learning to retrieve the item from memory.

The idea that stored representations involve features of items has been used in analyzing recall. In Bower's (29) model it is assumed that each item in memory is recalled if enough of its features are retained to satisfy a recall criterion. Missing features are filled in by the subject. A similar analysis of recall was given by Norman & Rumelhart (161), who assumed that in a recall test context information is made available and memory is accessed to find features of items studied in the context. If a sufficient number of features are retrieved to spedify an item uniquely, the subject gives that response. Otherwise, no response is given or the subject guesses.

Other discussions of recall by Kintsch (124) and Shiffrin (202) use the idea that items are stored in memory in a format involving features, including information about the time of study, and these features serve as a basis for search and retrieval of items. Cowan (47) gave a rigorous analysis of retrieval in the case where items are taken from two categories, based on the idea of differing associative strengths between items. And Albert (1) has analyzed interresponse times in the output of a learned list in terms of a linear death process, which he applied in a continuous form and also as a discrete-time urn model.

The role of short-term memory.—The role played by STM in memorizing for recall has been investigated in several studies. A major achievement of these analyses has been the development of a rigorous explanation of the serial position effect. Primacy is explained by the occurrence of extra processing of items studied at the beginning of the list, when STM is relatively uncrowded. Recency is explained by the fact that items studied at the end of the list are likely to still be in STM at the time of the test. Particular models embodying this general explanation differ to some extent. Waugh & Norman (235), Atkinson & Shiffrin (9), Norman & Rumelhart (161), Bower (28), and Reitman (183) assumed that STM is a discrete stage of processing, while Bernbach (17, 18) and Laughery (137) postulated a single memory system with a rehearsal process that has the property of making rehearsal more likely for recently presented items. Another difference is that Norman & Rumelhart (161) and Laughery (137) assumed that items are represented in STM as feature lists, thereby providing an explanation for effects of similarity, especially regarding intrusions. An alternative analysis of the serial position effect, based on concepts of retroactive and proactive inhibition, was given by Kuno (131). And Thomas (222) analyzed serial position effects with concepts from information theory.

Serial recall.—When the subject's task includes recalling items in the order of their presentation, theoretical analysis requires assumptions about the way in which information about order is stored and retrieved. In Laughery's (137) model, the data structure representing each item includes a substructure that holds the name of the following item. Thus order information is represented as a feature, capable of being lost from memory in the same way as other features of the item. Feigenbaum & Simon's (78) analysis of serial recall, based on the idea of a discrimination net, assumes that when a series of tests has been carried out, terminating at a node containing a response image, information that is stored along with the response image specifies the series of tests to be conducted to obtain the next item. And Lander (134, 135) has analyzed interassociations in serial learning from the standpoint of McGeoch's remote associates hypothesis.

Serial pattern learning.—We have all been aware, at least since Lashley's (136) convincing argument, that performance of many serially ordered tasks depends on an organization more sophisticated than item-to-item linkages. Vitz & Todd (233) have analyzed learning of binary sequences, concluding that events are encoded as runs of homogeneous events, and the structure that is acquired is a hierarchy involving runs of runs at each level. Restle (189) and Restle & Brown (190) have analyzed serial pattern learning of sequences of the numbers 1–6. Subsequences of short runs (e.g. 2345) and trills (e.g. 2323) are frequent bases of encoding, and sequences with hierarchical structures of these subunits are easily learned. Hierarchical structures are formed when movement from one subunit to the next can be accomplished using a transformation such as repetition, transposition (repeat the subunit with each element moved up or down by some fixed amount), or reflection (repeat the subunit, but with each element replaced by the element equally far from the opposite end of the array).

Simon & Kotovsky (204) analyzed the induction of a pattern from part of a letter sequence, postulating that subjects induce rules for generating the sequence based on relationships of identity and adjacency in the alphabet between entries in the sequence that are adjacent, or separated by one, or by two, and so on. Gregg's (95) analysis of sequential concept acquisition using patterns of switch settings provided information about the ways in which relations between patterns are encoded, as well as generating rules varying in complexity. Gyr, Brown & Cafagna (97) investigated models for inducing sequential patterns differing in the level of abstraction of hypotheses considered by the subject. Bjork's (22) analysis of the learning of arithmetic sequences assumes that rules induced by the subject may be constant (add or subtract n) or advancing (add or subtract one more than last time), and each component rule in the sequence is added to cognitive structure in an all-or-none fashion.

LEARNING TO RETRIEVE ITEMS ON CUE

After a paired associate is memorized, the subject is able to retrieve and perform the response term of the pair when the stimulus term is presented. Recent studies, following on prior analyses showing that in many experimental procedures memorizing of paired-associates is approximately an all-or-none process (see Estes 66), have provided more detailed analyses of the process of memorizing, or have considered situations in which the learning process has more than one stage.

The role of short-term memory.—Several analyses using the concept of rehearsal in STM have provided information about the way in which subjects adjust rehearsal procedures in relation to aspects of the learning situation. In continuous memorizing when the response for a stimulus is changed, the new item replaces the old one in STM, providing little interference with rehearsal of other items, although when an item with a new stimulus replaces the tested item it has approximately the same interfering effect as a new item (6). With a procedure requiring overt rehearsal, subjects enter all items in STM, and effectiveness of rehearsal is improved in the sense that the rate of information transfer to LTM is increased (9). A particularly interesting result was obtained in an experiment by Loftus reported by Atkinson & Wickens (10). Procedures were compared in which subjects either had to recall a letter response or had the easier task of selecting one of two alternative letters presented to them. The analysis indicated that with the two-choice procedure, subjects held only one item in STM at a time, entered nearly all presented items into STM, and rehearsed relatively efficiently; while with the recall procedure, subjects held about three items in STM at a time, about one-half of the items presented were not entered in STM, and rehearsal was less efficient.

As an approximation, STM can be represented as a Markov state, with an item assumed to occupy that state as long as it is in STM (7). This idea has been used in analyzing the greater difficulty of learning paired-associate items in longer lists (39), in analyzing perseverative errors in associative learning (14) and verbal discrimination (36), and in investigating the effect of spacing between the presentations of an item (23, 86). To analyze the effects of test trials given at varying intervals after study, Young (243) has postulated a system with two levels of STM, one of which involves probabilistic retrieval, and Izawa (114) has used the assumption that test trials may potentiate the effect of later study trials by causing unavailable stimulus elements to become effective.

Assumption of two learning stages.—In especially systematic and thorough empirical comparisons of alternative assumptions about paired-associate memorizing by Atkinson & Crothers (7) and by Cotton et al (46), results have shown that learning in some situations produces at least three levels of performance. Data in the form of sequences of errors and correct responses are unable, however, to support decisions between models differing in the subtler details of the way in which the performance levels are achieved. Suppes, Groen & Schlag-Rey (215) found that a model postulating at least two stages of learning was also required to analyze the latency of response during paired-associate memorizing. And

Kintsch (120) showed that a two-stage analysis could be used to analyze some of the cases in which Rock's (193) replacement procedure fails to yield results expected from the all-or-none assumption.

Analyses involving two postulated stages of learning are especially useful if there are hypotheses and supporting empirical results that specify the nature of the stages. One class of analyses has considered stages of learning relating to responses. Crothers (48) analyzed learning of associations with compound responses; the stages of learning corresponded to associating the response components with the stimulus. Bower & Theios (31) analyzed learning after change of response for a paired associate, where the first stage was unlearning the first association, made incorrect by the response change. Millward (149) and Nahinsky (156) examined a learning system in which the subject learns not to give certain responses that are incorrect, thereby improving performance prior to learning the correct association. Wolford (240) has assumed that forward and backward associations are stored, each in an all-or-none fashion. This idea provides an explanation of recognition and recall of either stimuli or responses.

Another class of hypotheses has attributed multiple stages in learning to requirements for discrimination between items in retrieving stored associations. Restle (187) proposed a two-stage theory in which the first stage is storage of an engram or representation of an association and the second stage is the formation of a distinctive trace, based on discovery of a discriminative feature. Polson, Restle & Polson (175) used the theory for analyzing a situation where confusions occurred between specific pairs of items, so that errors in the second stage were identifiable as responses to items similar to the one tested. Analyses using the mixed pattern-components model (8) have converged to a similar interpretation. Friedman & Gelfand (81) analyzed performance on tests after study of stimuli having shared components and different responses. The main hypotheses involve retention of association between stimulus patterns and their responses. Friedman, Trabasso & Mosberg (83) concluded that the learning of an item has two stages, and in the intermediate state there is uncertainty in the retrieval process if there are other items with some of the item's stimulus components. The completion of learning involves storing a representation of the association in which the stimulus is an integrated pattern, thus discriminating it from other similar stimuli.

In comparing recognition and recall performance after study of paired associates, Estes & DaPolito (69) obtained results consistent with Kintsch & Morris' (125) idea that one stage of learning allows the subject to recognize the item, but that a second stage may be needed to permit retrieval. Results obtained by Humphreys & Greeno (107) led to a further hypothesis that the first stage is storage of a representation of the stimulus-response pair as a kind of Gestalt unit, and the item is made reliably retrievable in the second stage. While this idea is consistent with certain findings obtained when results of negative transfer experiments are analyzed (89, 90), there are also experimental results supporting the alternative view of Underwood & Schulz (232) that the two main stages of associative learning are response acquisition and acquisition of stimulus-response connections (see Underwood 231).

Analyses of discrimination.—Several analyses, some mentioned above, have recognized stimulus discrimination as an important factor in paired-associate memorizing. Some investigators have proposed specific hypotheses about the process of discrimination learning. Bower (30) analyzed learning of paired associates whose stimuli are ordered on some linear dimension such as size. He showed that serial position effects that are obtained can be explained by assuming that the effective stimulus is a quantity corresponding to the magnitude of the nominal stimulus relative to the adaptation level determined by the set of stimuli. Bower also considered implications for learning and transfer of the idea that ordered stimuli are represented in a cognitive structure that has the general properties of a linear ordering.

Analyses of paired-associate memorizing based on the concept of a discrimination net have been given by Feigenbaum (76) and by Hintzman (101). Hintzman's analysis was particularly thorough and systematic, and had the especially useful feature of exploring the limits of the concept of stimulus discrimination in analyzing variables that influence difficulty of paired-associate memorizing. For example, it appears that appropriate assumptions about stimulus discrimination are sufficient to explain a variety of effects involving the number of response alternatives, spacing between presentations of an item, and interactions between amount of practice and interference of both the proactive and retroactive varieties But effects of list length on learning difficulty and some salient facts about negative transfer appear to require explanation involving other kinds of mechanisms.

STIMULUS-RESPONSE CONDITIONING

While studies of classical and instrumental conditioning have not enjoyed recently the popularity they had in years past, investigations of considerable significance and interest are still being conducted. Research based on quantitative models has been carried out on eyeblink conditioning, escape and avoidance conditioning, instrumental conditioning, and discriminative conditioning.

Eyeblink conditioning.—Eyeblink conditioning in rabbits was studied by Theios & Brelsford (220), who found that response sequences had the properties implied by a two-stage Markov model of the learning process. In eyeblink conditioning with human subjects, some results agree with the Markov model proposed by Bower & Theios (31), but Prokasy and his co-workers have found a slightly more complex form of the learning process—one in which performance remains at its initial level for some number of trials, then improves by an incremental process toward asymptotic performance. A model originally introduced by Norman (162) has parameters that give four measures of performance and learning: the initial level of performance, the number of trials before performance begins to change, the rate of change in performance once it starts changing, and the asymptotic level of performance. The model has been applied to analyze effects of the intensity of an unconditioned stimulus (180), as well as effects of interstimulus interval and the difference in performance between subjects classified as voluntary and involuntary responders (181). The model has also been useful in separating the learning and performance effects of certain drugs on conditioned responding in rats (234).

Shock-escape and avoidance conditioning.—The two-stage Markov model has also been used in analyzing shock-escape training (31, 216), and has provided an analysis of the effects of overtraining and successive reversals on reversal learning in a shock-escape T-maze (217). The process of conditioning an avoidance response also has been studied with the two-stage Markov model (31). Theios & Brelsford (221) found evidence that the first stage of learning is the conditioning of the instrumental response of running when frightened, while the second stage involves storing a permanent record of the association between the conditioned stimulus and the emotional arousal response. A series of experiments conducted by Brelsford (33) tested specific implications of Theios & Brelsford's interpretation of avoidance conditioning, and provides excellent examples of the way in which specific quantitative theorizing can generate innovative experimental procedures as a means of providing strong tests of hypotheses. Theios (219) has provided an informative review of analyses of aversive conditioning carried out in his laboratories.

Gibbon (85) has investigated free-operant avoidance in some detail, with particular emphasis on how asymptotic responding is sustained. In his view, asymptotic behavior can be treated as a combination of reconditioning and extinction, and he derives predictions of both interresponse and intershock intervals on the basis of a finite state (semi-Markov chain) interpretation of behavior at asymptote.

Instrumental conditioning.—Norman (163) analyzed instrumental conditioning as reflected by changes in interresponse time distributions as a function of schedules in which reinforcement probability is contingent on interresponse time. In his analysis of asymptotic interresponse time distributions under random ratio, variable interval, and DRL-like schedules, Norman assumed that nonreinforcement of a response increases the likelihood of long interresponse times, and that the reinforcement of a response characterized by a particular interresponse time t both increases the likelihood of short interresponse times and increases the likelihood of interresponse times about equal to t.

Discriminative conditioning.—Nearly all recent theoretical work on instrumental conditioning has been carried out with respect to situations in which discrimination plays a major role. Several approaches have been used in analyses of discrimination learning.

Lovejoy (140, 141) gave a thorough discussion of experimental findings concerned with attention in discrimination learning, and used these as a guide in developing assumptions of a theory. The theory, in which reinforcement influences the tendency to attend to the various stimulus dimensions and the strength of response associated with individual stimulus properties, was shown to be consistent with many facts in the complex and often puzzling literature of discriminative instrumental conditioning.

Other investigators have applied assumptions of discrete changes in state in analyzing discrimination learning. Clayton (41) analyzed the learning of a simple spatial discrimination in terms of the three-state version of all-or none learning stated by Greeno & Steiner (94). He examined in some detail the influence of several experimental variables, such as magnitude of reward and correction or noncorrection, on the transition probabilities in the model. In general, Clayton found support for the notion that such simple discriminations are learned in an all-or-none fashion, and he was able to demonstrate that events following a correct response are the primary determiners of the probability of transition to the learned state.

Another analysis using discrete changes in state was given by Lee (138), who assumed that each discrete stimulus used or each point on a stimulus continuum is in one of two states, conditioned to one of the response alternatives, and stimuli similar to one given on a trial have relatively high probability of changing state because of reinforcement given on the trial. Analyses have also been given in which the subject is assumed to go through discrete changes in state regarding the discrimination learning problem. Massaro (145) postulated a three-state system with the subject having either an appropriate or inappropriate strategy or being unconditioned. In a theory by Lynn (143), used to analyze discrimination by monkeys, it was assumed that the subject either has learned the correct response for a problem or is in the unlearned state, but throughout the problem there is a probability of not attending appropriately to the stimuli.

Analyses based on the idea that learning involves gradual quantitative change have been given by Holman (103, 105), who has been concerned with the relative effects of reward and nonreward on simple discriminative learning in rats. In his view, in order to isolate the functional form of the learning process one needs to untangle the effects of reward and nonreward, which are intertwined under normal circumstances. Holman has found (105) that when response probability is low events that increase response probability (reward) are more effective in changing behavior than are events that decrease response probability (nonreward), and when response probability is high the opposite is true. Holman (103) interpreted spontaneous alternation in the T-maze running of rats in terms of the differential effects of reward and nonreward, and he derived predictions of alternation behavior on the basis of that interpretation.

Durup (52–55) has also developed techniques for measuring changes of different kinds that occur during discrimination learning. The basis of the analysis is a model of choice behavior in which choice occurs in several stages, making the response a result of a random walk process (26, 63), and the model permits separation of learning to approach a positive alternative from learning to avoid a negative alternative. A particularly interesting development is Durup's interpretation of the stages of choice in the random walk model in relation to theoretical processes of attention, memory, and decision (56), thus connecting the random walk model with theoretical analyses like Lovejoy's (140, 141).

Classical continuity theory has been used by Spiker (207) as the basis for an extension of Hull-Spence discrimination learning theory. And Wolford & Bower

(241) have shown that some empirical results thought to oppose continuity theory are compatible with it.

A final example of theoretical work on discriminative conditioning is the work of Boneau & Cole (25), who used the ideas of statistical decision theory to analyze asymptotic performance in discriminative conditioning. They assumed that stimuli have variable effects, so that a given effective stimulus is associated with reinforcement probabilistically, and decisions whether to respond depend on the value of the reinforcement, the cost of responding, and the remembered frequency of reinforcement on past occasions of the effective stimulus.

ACQUIRING INFORMATION FOR CHOICE AND DECISION

The extensive theoretical work on sequential choice behavior during the last decade or so is a topic worthy in and of itself for an *Annual Review* chapter. The situations studied have involved discrete responses and response continuums, learnable and nonlearnable sequences, contingent and noncontingent outcome schedules, and variations in reward and reward schedules. Fortunately, there exist three excellent review articles that cover essentially all of the quantitative theorizing in this domain. In his article on probability learning in 1964, Estes (67) reviewed developments up to that point. Myers' systematic article in 1970 (155) gives an overview of theoretical work on sequential choice behavior and covers his own extensive work on the topic in some detail. Finally, Estes' recent theoretical review (68) of probability learning provides an integrative review of theoretical developments up to the same point in time as our review.

We will not review in sketchy form here the material reviewed so well in the three articles mentioned above. Rather, we refer the reader to those articles, and confine ourselves to a remark that the theoretical developments in the area of sequential choice behavior are an important component of the emerging psychology of learning and cognition that is pointed to in the introduction to this chapter. As Myers (155) emphasized, probability learning was interpreted almost exclusively in a conditioning framework until the middle 1960s. Since that time, an ever-increasing number of theories of sequential choice behavior emphasize cognitive processes such as encoding, chunking, hypothesis testing, and so forth. Thus, during the last decade, theorists have shifted their attention from the way in which response probabilities change with reward or nonreward to the way in which information processing mechanisms determine, on the basis of the past sequence of events, the current choice or series of choices.

LEARNING CLASSIFICATION RULES

Single dimensional rules.—In experimental tasks requiring subjects to classify stimuli into categories, learning is mainly the acquisition of a rule relating properties of stimuli to response. A substantial number of studies have been carried out in relation to Restile's (185) rigorous development of the idea that rule learning involves selection from a set of possibilities. Bower & Trabasso (32) derived many theorems about statistical properties of data and carried out a number of experiments giving startlingly good empirical support for the model, especially regarding the counterintuitive assumption that sampling from the hypothesis set occurs with replacement. Further work by Trabasso & Bower (228) provided thorough analysis of the implications of the idea of learning by selection for situations involving transfer of training, variation in cue salience and number of irrelevant cues, and overtraining. A clarification of a basic mathematical property of the model has been given by Fisher (79). Cotton (45) has given a substantive extension of the model dealing with dependence of response prior to solving the problem on trial-to-trial relationships between stimuli.

Falmagne (72) presented an analysis based on assuming that performance improves gradually over trials according to a linear operator, but at some random trial the solution is found and the correct response is known for all stimuli. In another analysis, Falmagne (74) assumed that sampling weights of hypotheses are altered by confirmations and disconfirmations that occur. Her analysis also provides a way of estimating the probability of resampling after errors and correct responses, and the frequency of a passive state in which subjects respond on the basis of no hypothesis about the classification rule. The statistical methods were used to test hypotheses about effects of the intertrial interval used in concept identification (75).

Several analyses have been given dealing with the role of STM in the process of learning a classification rule in a concept identification experiment. Trabasso & Bower (227) showed that results obtained when the relevant dimension shifts after every other error refute the assumption of sampling with no memory, and proposed an assumption that subjects remember stimulus characteristics on successive trials and then for three or four trials avoid sampling cues that are inconsistently paired with responses. Gregg & Simon (96) described four alternative theories, varying in depth of memory storage during concept identification; their estimates of the memory parameter indicated relatively weak use of memory by subjects.

Two theories have been proposed asuming that the role of memory in concept identification primarily involves retention of information about hypotheses that the subject is considering as possible solutions. Chumbley (40) analyzed solution of a four-dimension problem, assuming that the subject considers all four possible dimensions, eliminating hypotheses on the basis of stimulus information, but sometimes losing track after errors. The frequency of losing track of the hypothesis set was found to increase with shorter intertrial intervals and with a requirement of dealing with three concurrent problems rather than a single problem. Wickens & Millward (239) analyzed solution of a 12-dimension problem by practiced subjects. They concluded that subjects have STM capacities varying from one to four for hypotheses under active consideration, and when all hypotheses in STM have been eliminated those possiblities are kept out of the set available for sampling. On the other hand, there is a limitation on the number of eliminated hypotheses that the subject can remember, so that some eliminated hypotheses eventually return to the set of potential solutions.

Multidimensional rules.—Analyses have also been given for acquisition of conceptual rules more complex than those involving a single stimulus dimension. The simplest case involves learning a four-way classification consisting of a two-by-two table of binary dimensions. Trabasso & Bower (226) analyzed this case as independent selection of the two relevant stimulus attributes. Nahinsky (157) analyzed learning of conjunctive classification, assuming that acquisition occurs on the basis of sampling from the set of two-cue combinations, with focusing occurring on both positive and negative instances, and retention of the first stimulus-response pair shown in the experiment. Another analysis of concept learning based on the idea of hypothesis sampling was given by Joyner (118), who considered solution of a problem in which three players individually give numbers, with the goal of having the sum of their numbers equal a target number. In this case the elements of the hypothesis set reflect the subjects' knowledge of basic arithmetic operations.

As an alternative to the assumption of selection from a set of hypotheses, an assumption that positive and negative instances are stored and then scanned to find defining properties also has been used in analyses of concept identification. Hunt & Hovland (111) gave an analysis using this idea, including the assumption that a limited set of dimensions is used in the scanning process at any one time. Johnson (116) presented a more elaborate system, with a mechanism for selecting among subclasses of stimulus attributes for consideration, and special subroutines for attempting to find conjunctive and disjunctive solution concepts. In a somewhat more formal analysis, Mott & Ross (152) described an algorithm for generating a list of possible concepts from a set of positive and negative instances based on the logical theory of implicants of an incomplete truth function.

Hunt and his co-workers have given analyses of the process of learning rules for classification, using the powerful conceptual method of representing the acquired concept as a decision tree (108). Hunt, Marin & Stone (112) tested systems varying in their sophistication in choosing stimulus items for test as well as in the amount of memory that was given to the system. Studies of the efficiency of the systems were carried out, as well as comparisons of simulated concept learning with performance by human subjects. Hunt (109) examined further variations regarding the method of selecting attributes for test and for assigning a label when an instance is encountered that is not specified on the basis of earlier learning.

Classification in associative learning.—Some attention has been given to the process of acquiring a classification rule during the course of paired-associate memorizing, when relationships among items can be used to simplify the task by grouping related items that have the same response. The situations studied have used the conditions of short lists and few response alternatives so the process of associative learning is approximately all-or-none. Then the transfer of association to new instances appears also to be an all-or-none process (92). The process of acquiring a category rule has been analyzed by Batchelder (11) as an all-or-none process, and data appear to favor that idea over the mixed pattern-components model of stimulus sampling theory (12).

FORMAL ASPECTS OF MATHEMATICAL MODELS

In this final section we will first present a brief classification of types of mathematical learning theory, based on their mathematical properties rather than their substantive assumptions. Then we will review contributions to theory of a primarily methodological nature, concerned with formal properties of models, including issues involved in evaluation.

Types of Theory

A major dimension of variation among mathematical theories of learning involves the degree to which specific mental processes are postulated. At one end of this continuum are quantitative descriptions of performance, where the only theoretical entity is response probability. Experimental events (trials) have effects on response probability represented by operators, and effects of experimental variables are represented by changes in the values of parameters of the transformational operators. Theories that specify characteristics of psychological process and structure in more detail provide fuller explanation of performance, but more importantly give more exact understanding of the system studied. We differ from some commentators (96) who seem to see discrete categories of theory, such as "stochastic models," that are different in kind from "process models" or other similar dichotomies. Our view is that various theories about any process will vary both in their degrees of specificity and in the kinds of specific process assumed. Furthermore, the amount of specificity built into a theory at any stage of knowledge represents an important dimension of research strategy. And since research strategies apparently pay off more or less randomly, it is almost surely to the benefit of science that different investigators tend to choose different strategies, so the scientific community has what amounts to a portfolio of strategies in order to benefit from whatever advantages the various approaches may have for different problems at various stages of progress.

While theories differ in specificity in a more or less continuous fashion, there are some benchmarks. One step toward specificity is an assumption of a state space, with different levels of performance associated with the various states, and learning represented as transition among the states. More specificity is achieved in a stochastic model in which the states are interpreted as conditions of cognitive status, such as those given in Figure 1 of this article, or as stages of learning or problem solving involving specific cognitive achievement such as storage of representations. Even more specific assumptions are made in some theories, often in connection with the need to specify processes sufficiently so that an operating computer program can be written in an available programming language. It is reasonable to suppose that some of the processes described summarily in an information-processing theory, such as scanning a list and comparing with a test item, might be described in some detail in a theory dealing with processes in a more molecular way.

In our view, there is no argument against the goal of describing cognitive processes in more specific ways, as well as having descriptions that apply to a wide variety of situations in which learning and other cognitive processes occur. At the same time, significant questions remain as to optimal strategy to be used at any given stage of theoretical progress and empirical knowledge about the processes that occur in accomplishing various tasks. Given the empirical knowledge that is available regarding a process, some possible statements of hypotheses are so general that their likelihood of falsification in data is negligible, and they probably have poor prospects for providing a basis for significant new knowledge and understanding. At the same time, other possible hypotheses involve so many detailed assumptions that go beyond available empirical evidence that they are sure to be refuted in their first confrontation with data. While it can be instructive to see a combination of assumptions that are mutually consistent and capable of giving successful performance on a complex task, it remains the task of science to develop testable hypotheses that can be challenged meaningfully in experiments, and an overabundance of detail in a theory can often preclude the use of experimental findings in guiding modifications of theory toward more accurate description. These cautions notwithstanding, we suspect that the current state of knowledge about learning is such that quite a variety of theoretical approaches are likely to lead to meaningful advances in knowledge and understanding, and we are encouraged by the relatively broad band of degrees of specificity in current theoretical work.

Mathematical and Statistical Studies

A considerable number of investigations have occurred where mathematical models are studied from the point of view of their general properties or statistical considerations involved in their application. Norman & Yellott (170) investigated properties of models that lead to probability matching, and convergence and limit properties that follow from several general assumptions about learning operators have been studied by Norman and others (104, 147, 164–169, 242). There have also been analyses of families of learning operators characterized by properties such as commutativity (142, 144), and generalizations of discrete models, such as those deriving from stimulus sampling theory, as continuous-time processes (4, 51, 213).

Suppes (210) studied asymptotic properties of learning systems formulated on the basis of stimulus-response principles, and showed that they can have limiting properties that make them isomorphic to finite automata with many of the characteristics needed to describe language and other complex behavior. Discussion of the status of this result by Arbib (3) and Suppes (211) has emphasized the importance of determining the number of states needed to produce performance that people show when they use language.

Both the linear model and the all-or-none model have been the topic of mathematical studies. Some analyses have generalized the linear model (21, 113, 165), and several mathematical studies of the all-or-none model have been carried out. Two aspects of the all-or-none assumption have been distinguished, with several investigators noting that stationarity of performance before learning and constancy of the probability of learning involve separate assumptions (73, 177, 188, 196). Rouanet et al (196) have given careful discussion of the way in which individual differences can influence tests of the all-or-none model. An especially promising development has been the use of the all-or-none model (119, 205) and other more general models (49) in the analysis of item-presentation sequences in order to develop presentation strategies that optimize learning efficiency.

A considerable literature is developing dealing with technical matters such as parameter estimation and evaluation of learning models. Bernbach (15) and Millward (150) have given general methods of deriving empirical predictions from Markov models. General discussions of estimation have been given by Holland and Kraemer (102, 126–128). A thorough discussion of all-or-none parameters by Polson (176) deals with estimation as well as tests of hypotheses. Theios (218) has given a method of estimating performance parameters and trials of transition appropriate for experiments having many responses in each subject's sequence of performance. Regarding evaluation of models, Rouanet (194) has given an analysis based on relationships between models that deal with varying degrees of fine-grainedness in the partition of experimental events, and Regnier & Rouanet (182) have shown that different interpretations of all-or-none learning can be distinguished empirically by moving to a finer partition of events in which a subject's complete performance is considered. Questions involving statistical tests of goodness-of-fit continue to be raised (96), and Kraemer (129) and Hanna (98) have proposed alternatives to the standard and still much-used indices such as goodness-of-fit chi square.

Investigations have been made of the kinds of inference that can be justified on the basis of experimental data. Richard (192) and Jonkheere (117) have considered examples in which different psychological processes can lead to identical empirical predictions and thus not to distinguishable in data. A specific form of of this problem arises when a mathematical model has more parameters than can be identified on the basis of data from specific kinds of experiments, and several models have been analyzed regarding the identifiability of parameters (7, 86, 88, 91, 93, 94, 208).

TEXTBOOKS

Texts by Galanter (84) and Greeno (87) have been written for beginning undergraduates with emphasis on systematic theory and inclusion of mathematical models of learning. For more advanced undergraduates or beginning graduate students, Atkinson, Bower & Crothers' (5) text presents the basic concepts of stimulus sampling theory, includes application to a number of problems, and gives considerable attention to techniques of use. A book of problems by Batchelder, Bjork & Yellott (13) is available. Rouanet's (195) text also introduces basic concepts of stimulus sampling theory, and provides an excellent introduction to the theory of conditioning on a continuum of responses. Restle & Greeno's

LITERATURE CITED

1. Albert, D. 1968. Freies Reproduzieren von Wortreihen als stochastische Entleerung eines Speichers. *Z. Exp. Angew. Psychol.* 15:564–81
2. Alpern, M. 1953. Metacontrast. *J. Opt. Soc. Am.* 43:648–57
3. Arbib, M. A. 1969. Memory limitations of stimulus-response models. *Psychol. Rev.* 76:507–14
4. Arnold, B. C. 1967. Response distribution for the continuous-time N-element pattern model. *J. Math. Psychol.* 4:489–500
5. Atkinson, R. C., Bower, G. H., Crothers, E. J. 1965. *Introduction to Mathematical Learning Theory.* New York: Wiley. 429 pp.
6. Atkinson, R. C., Brelsford, J. W., Shiffrin, R. M. 1967. Multiprocess models for memory with applications to a continuous presentation task. *J. Math. Psychol.* 4:277–300
7. Atkinson, R. C., Crothers, E. J. 1964. A comparison of paired-associate learning models having different acquisition and retention axioms. *J. Math. Psychol.* 1:285–315
8. Atkinson, R. C., Estes, W. K. 1963. *Handbook of Mathematical Psychology*, ed. R. D. Luce, R. R. Bush, E. Galanter, 121–268. New York: Wiley. 606 pp.
9. Atkinson, R. C., Shiffrin, R. M. 1968. *The Psychology of Learning and Motivation*, ed. K. W. Spence, J. T. Spence, 2:90–197. New York: Academic. 255 pp.
10. Atkinson, R. C., Wickens, T. D. 1971. *The Nature of Reinforcement*, ed. R. Glaser, 66–120. New York: Academic. 379 pp.
11. Batchelder, W. H. 1970. An all-or-none theory for learning on both the paired-associate and concept levels. *J. Math. Psychol.* 7:97–117
12. Ibid 1971. A theoretical and empirical comparison of the all-or-none multilevel theory and the mixed model. 8:82–108
13. Batchelder, W. H., Bjork, R. A., Yellott, J. I. Jr. 1966. *Problems in Mathematical Learning Theory.* New York: Wiley. 184 pp.
14. Bernbach, H. A. 1965. A forgetting model for paired-associate learning. *J. Math. Psychol.* 2:128–44
15. Bernbach, H. A. 1966. Derivation of learning process statistics for a general Markov model. *Psychometrika* 31:225–34
16. Bernbach, H. A. 1967. Decision processes in memory. *Psychol. Rev.* 74:462–80
17. Bernbach, H. A. 1969. *The Psychology of Learning and Motivation*, ed. G. H. Bower, J. T. Spence, 3:201–40. New York: Academic. 398 pp.
18. Bernbach, H. A. 1970. See Ref. 160, 103–16
19. Bernbach, H. A. 1971. Strength theory and confidence ratings in recall. *Psychol. Rev.* 78:338–40
20. Binder, A., Estes, W. K. 1966. Transfer of response in visual recognition situations as a function of frequency variables. *Psychol. Monogr.* 80:Whole no. 631
21. Bishir, J., Drewes, D. W. 1969. A generalized linear learning model. *J. Math. Psychol.* 6:121–38
22. Bjork, R. A. 1968. All-or-none subprocesses in the learning of complex sequences. *J. Math. Psychol.* 5:182–95
23. Bjork, R. A. 1970. See Ref. 160, 307–32
24. Blough, D. S., Millward, R. B. 1965. Learning: Operant conditioning and verbal learning. *Ann. Rev. Psychol.* 16:63–94
25. Boneau, C. A., Cole, J. L. 1967. Decision theory, the pigeon, and the psychophysical function. *Psychol. Rev.* 74:123–35
26. Bower, G. H. 1959. *Studies in Mathematical Learning Theory*, ed. R. R. Bush, W. K. Estes, 109–24. Stanford Univ. Press. 432 pp.
27. Bower, G. H. 1961. Application of a model to paired-associate learning. *Psychometrika* 27:255–80
28. Bower, G. H. 1967. *Proceedings of the Second Conference on Learning, Remembering, and Forgetting*, ed. D. P. Kimble, 112–85. New York: NY Acad. Sci.
29. Bower, G. H. 1967. *The Psychology of Learning and Motivation*, ed. K. W. Spence, J. T. Spence, 1:230–327. New York: Academic. 381 pp.
30. Bower, G. H. 1971. *Adaptation Level Theory*, ed. M. H. Appley, 175–201. New York: Academic. 346 pp.
31. Bower, G. H., Theios, J. 1964. *Studies in Mathematical Psychol-*

ogy, ed. R. C. Atkinson, 1–31. Stanford Univ. Press. 414 pp.

32. Bower, G. H., Trabasso, T. R. 1964. See Ref. 31, 32–94
33. Brelsford, J. W. Jr. 1967. Experimental manipulation of state occupancy in a Markov model for avoidance conditioning. *J. Math. Psychol.* 4:21–47
34. Broadbent, D. E. 1958. *Perception and Communication*. London: Pergammon. 338 pp.
35. Brown, J. 1958. Some tests of the decay theory of immediate memory. *Quart. J. Exp. Psychol.* 10: 12–21
36. Buchwald, A. M. 1969. Effects of "right" and "wrong" on subsequent behavior: A new interpretation. *Psychol. Rev.* 76:132–43
37. Bush, R. R., Mosteller, F. 1951. A model for stimulus generalization and discrimination. *Psychol. Rev.* 58:413–23
38. Bush, R. R., Mosteller, F. 1955. *Stochastic Models for Learning*. New York: Wiley. 365 pp.
39. Calfee, R. C., Atkinson, R. C. 1965. Paired-associate models and the effects of list length. *J. Math. Psychol.* 2:254–65
40. Chumbley, J. 1969. Hypothesis memory in concept learning. *J. Math. Psychol.* 6:528–40
41. Clayton, K. N. 1969. *Reinforcement and Behavior*, ed. J. T. Tapp, 96–119. New York: Academic. 429 pp.
42. Collins, A. M., Quillian, M. R. 1969. Retrieval time from semantic memory. *J. Verb. Learn. Verb. Behav.* 8: 240–47
43. Conrad, R. 1964. Acoustic confusion in immediate memory. *Brit. J. Psychol.* 55:75–84
44. Coombs, C. H., Dawes, R. M., Tversky, A. 1970. *Mathematical Psychology: An Elementary Introduction*. Englewood Cliffs, N. J.: Prentice-Hall. 419 pp.
45. Cotton, J. W. 1971. A sequence-specific concept identification model: Infra-structure for the Bower and Trabasso theory. *J. Math. Psychol.* 8:333–69
46. Cotton, J. W., Sloss, J. M., Taplin, J. R., Nielson, A. E. 1968. A comparison of a Hullian paired-associate learning model with other models appropriate to an R^NT^6 design with 1:1 pairing of stimuli and responses. *J. Math. Psychol.* 5:442–62
47. Cowan, T. M. 1966. A Markov model for order of emission in free recall. *J. Math. Psychol.* 2:470–83
48. Crothers, E. J. 1964. See Ref. 31, 95–115
49. Crothers, E. J. 1965. Learning model solution to a problem in constrained optimization. *J. Math. Psychol.* 2:19–25
50. Donaldson, W., Glathe, H. 1970. Signal-detection analysis of recall and recognition memory. *Can. J. Psychol.* 24:42–56
51. Donio, J. 1969. Stimulus sampling learning models described as continuous-time stochastic processes. *J. Math. Psychol.* 6:240–57
52. Durup, H. 1964. Un modèle stochastique du comportement conduisant à la réponse, chez un animal en situation d'apprentissage discriminatif. I. Apprentissage sans correction, première approximation. *Cah. Psychol.* 7:21–29
53. Ibid. II. Apprentissage sans correction, seconde approximation, 57–59
54. Ibid 1965. III. Apprentissage avec correction. 8:89–99
55. Ibid 1966. IV. Rôle du modèle comme hypothèse nulle par rapport à des résultats expérimentaux. 9:65–73
56. Ibid. Les modèles à cheminement aléatoire et l'analyse du comportement de choix discriminatif, 135–42
57. Erickson, J. R. 1968. Hypothesis sampling in concept identification. *J. Exp. Psychol.* 76:12–18
58. Ernst, G. W., Newell, A. 1969. *GPS: A Case Study in Generality and Problem Solving*. New York: Academic
59. Estes, W. K. 1950. Toward a statistical theory of learning. *Psychol. Rev.* 57:94–107
60. Ibid 1955. Statistical theory of distributional phenomena in learning. 62:369–77
61. Ibid. Statistical theory of spontaneous recovery and regression, 145–54
62. Estes, W. K. 1959. *Psychology: A Study of a Science. General Systematic Formulations, Learning, and Special Processes*, ed. S. Koch, 2:380–491. New York: McGraw-Hill. 706 pp.
63. Estes, W. K. 1960. *Mathematical Methods in the Social Sciences*, ed.

K. J. Arrow, S. Karlin, P. Suppes, 265–76. Stanford Univ. Press
64. Estes, W. K. 1961. New developments in statistical behavior theory: Differential tests of axioms for associative learning. *Psychometrika* 26:73–84
65. Estes, W. K. 1962. Learning theory. *Ann. Rev. Psychol.* 13:107–44
66. Estes, W. K. 1964. All-or-none processes in learning and retention. *Am. Psychol.* 19:16–25
67. Estes, W. K. 1964. *Categories of Human Learning*, ed. A. W. Melton, 89–128. New York: Academic. 356 pp.
68. Estes, W. K. 1972. Research and theory on the learning of probabilities. *J. Am. Statist. Assoc.* 67:81–102
69. Estes, W. K., DaPolito, F. 1967. Independent variation of information storage and retrieval processes in paired-associate learning. *J. Exp. Psychol.* 75:18–26
70. Estes, W. K., Suppes, P. 1959. See Ref. 26, 137–79
71. Estes, W. K., Taylor, H. A. 1964. A detection method and probabilistic models for assessing information processing from brief visual displays. *Proc. Nat. Acad. Sci.* 52: 446–54
72. Falmagne, R. 1965. Un modèle mixte pour la situation d'identification de concepts. *Bull. Etudes Rech. Psychol.* 14:219–41
73. Falmagne, R. 1969. Le caractère tout-ou-rien ou progressif de l'apprentissage de concepts: Discussion théorique et examen de résultats expérimentaux. *Année Psychol.* 69:143–60
74. Falmagne, R. 1970. Construction of a hypothesis model for concept identification. *J. Math. Psychol.* 7:60–96
75. Ibid 1971. Concept identification: Effect of the intertrial interval on the efficacy and consistency of information processing. 8:240–47
76. Feigenbaum, E. A. 1963. See Ref. 77, 297–309
77. Feigenbaum, E. A., Feldman, J., Eds. 1963. *Computers and Thought.* New York: McGraw-Hill. 535 pp.
78. Feigenbaum, E. A., Simon, H. A. 1962. A theory of the serial position effect. *Brit. J. Psychol.* 53:307–20
79. Fisher, M. A. 1971. A note on the generalization of some results in hypothesis sampling theory. *J. Math. Psychol.* 8:235–39
80. Freund, R. D., Loftus, G. R., Atkinson, R. C. 1969. Applications of multiprocess models for memory to continuous recognition tasks. *J. Math. Psychol.* 6:576–94
81. Friedman, M. P., Gelfand, H. 1964. Transfer effects in discrimination learning. *J. Math. Psychol.* 1:204–14
82. Friedman, M. P., Rollins, H., Padilla, G. 1968. The role of cue validity in stimulus compounding. *J. Math. Psychol.* 5:300–10
83. Friedman, M. P., Trabasso, T., Mosberg, L. 1967. Tests of a mixed model for paired-associates learning with overlapping stimuli. *J. Math. Psychol.* 4:316–34
84. Galanter, E. 1966. *Textbook of Elementary Psychology.* San Francisco: Holden-Day. 419 pp.
85. Gibbon, J. 1971. Scalar timing and semi-Markov chains in free-operant avoidance. *J. Math. Psychol.* 8:109–38
86. Greeno, J. G. 1967. Paired-associate learning with short-term retention: Mathematical analysis and data regarding identification of parameters. *J. Math. Psychol.* 4:430–72
87. Greeno, J. G. 1968. *Elementary Theoretical Psychology.* Reading, Mass.: Addison-Wesley, 324 pp.
88. Greeno, J. G. 1968. Identifiability and statistical properties of two-stage learning with no successes in the initial stage. *Psychometrika* 33:173–216
89. Greeno, J. G. 1970. See Ref. 160, 261–84
90. Greeno, J. G., James, C. T., DaPolito, F. J. 1971. Cognitive interpretation of negative transfer and forgetting of paired associates. *J. Verb. Learn. Verb. Behav.* 10: 331–45
91. Greeno, J. G., Millward, R. B., Merryman, C. T. 1971. Matrix analysis of identifiability of some finite Markov chains. *Psychometrika* 36:389–408
92. Greeno, J. G., Scandura, J. M. 1966. All-or-none transfer based on verbally mediated concepts. *J. Math. Psychol.* 2:388–411
93. Greeno, J. G., Steiner, T. E. 1964. Markovian processes with identifiable states: General considerations

and application to all-or-none learning. *Psychometrika* 29:309–33

94. Ibid 1968. Comments on "Markovian processes with identifiable states: General considerations and application to all-or-none learning." 33:169–72
95. Gregg, L. W. 1967. *Concepts and the Structure of Memory*, ed. B. Kleinmuntz, 107–42. New York: Wiley. 286 pp.
96. Gregg, L. W., Simon, H. A. 1967. Process models and stochastic theories of simple concept formation. *J. Math. Psychol.* 4:246–76
97. Gyr, J. W., Brown, J. S., Cafagna, A. C. 1967. Quasiformal models of inductive behavior and their relation to Piaget's theory of cognitive stages. *Psychol. Rev.* 74:272–89
98. Hanna, J. F. 1969. Some information measures for testing stochastic models. *J. Math. Psychol.* 6:294–311
99. Haygood, R. C., Bourne, L. E. Jr. 1965. Attribute- and rule-learning aspects of conceptual behavior. *Psychol. Rev.* 72:175–95
100. Hinrichs, J. V. 1970. A two-process memory-strength theory for judgment of recency. *Psychol. Rev.* 77: 223–33
101. Hintzman, D. L. 1968. Explorations with a discrimination net model for paired-associate learning. *J. Math. Psychol.* 5:123–62
102. Holland, P. W. 1968. A remark on Bower's estimate for the one-element Markov learning model. *Psychometrika* 33:217–24
103. Holman, E. W. 1966. Tests for spontaneous alternation. *Psychol. Rev.* 73:427–36
104. Holman, E. W. 1969. Asymptotic properties of monotonic learning models. *J. Math. Psychol.* 6:456–69
105. Ibid. The relative effects of reward and nonreward in simple learning, 497–513
106. Hull, C. L. 1952. *A Behavior System.* New Haven: Yale Univ. Press
107. Humphreys, M., Greeno, J. G. 1970. Interpretation of the two-stage analysis of paired-associate memorizing. *J. Math. Psychol.* 7:275–92
108. Hunt, E. B. 1962. *Concept Learning: An Information Processing Problem.* New York: Wiley. 286 pp.
109. Hunt, E. B. 1967. See Ref. 95, 77–106
110. Hunt, E. 1968. Computer simulation: Artificial intelligence studies and their relevance to psychology. *Ann. Rev. Psychol.* 19:135–68
111. Hunt, E. B., Hovland, C. I. 1963. See Ref. 77, 310–28
112. Hunt, E. B., Marin, J., Stone, P. I. 1966. *Experiments in Induction.* New York: Academic. 247 pp.
113. Iosifescu, M., Theodorescu, R. 1965. On Bush-Mosteller stochastic models for learning. *J. Math. Psychol.* 2:196–203
114. Izawa, C. 1971. The test trial potentiating model. *J. Math. Psychol.* 8:200–24
115. James, W. 1890. *The Principles of Psychology.* New York: Dover
116. Johnson, E. S. 1964. An information-processing model of one kind of problem solving. *Psychol. Monogr.* 78:Whole no. 581
117. Jonkheere, A. R. 1967. *Les Modelès et la Formalisation du Comportement*, 405–11. Paris: Centre Nat. Rech. Sci. 424 pp.
118. Joyner, R. C. 1970. Computer simulation of individual concept learning in the three-person common target game. *J. Math. Psychol.* 7:478–514
119. Karush, W., Dear, R. E. 1966. Optimal stimulus presentation strategy for a stimulus sampling model of learning. *J. Math. Psychol.* 3:19–47
120. Kintsch, W. 1963. All-or-none learning and the role of repetition in paired-associate learning. *Science* 140:310–12
121. Kintsch, W. 1966. Recognition learning as a function of the length of the retention interval and changes in the retention interval. *J. Math. Psychol.* 2:412–33
122. Kintsch, W. 1967. Memory and decision aspects of recognition learning. *Psychol. Rev.* 74:496–504
123. Kintsch, W. 1970. *Learning, Memory, and Conceptual Processes.* New York: Wiley. 498 pp.
124. Kintsch, W. 1970. See Ref. 160, 333–74
125. Kintsch, W., Morris, C. J. 1965. Application of a Markov model to free recall and recognition. *J. Exp. Psychol.* 69:200–6
126. Kraemer, H. C. 1963. Comments on parameter estimation for Restle's theory of cue learning. *Psychometrika* 28:185–88
127. Ibid 1964. Estimation in the three-state Markov learning model. 29: 131–41

128. Kraemer, H. C. 1964. Point estimation in learning models. *J. Math. Psychol.* 1:28–53
129. Kraemer, H. C. 1965. The average error of a learning model, estimation and use in testing the fit of models. *Psychometrika* 30:343–52
130. Kuhn, T. S. 1962. *The Structure of Scientific Revolutions.* Univ. Chicago Press. 172 pp.
131. Kuno, U. 1965. A model for serial verbal learning. *Psychometrika* 30: 323–41
132. Landauer, T. K. 1969. Reinforcement as consolidation. *Psychol. Rev.* 76:82–96
133. Landauer, T. K., Freedman, J. L. 1968. Information retrieval from long-term memory: Category size and recognition time. *J. Verb. Learn. Verb. Behav.* 7:291–95
134. Lander, H. J. 1969. Beiträge zur Psychologie des Gedächtnisses VI; Über Strukturbildungsprozesse beim menschlichen Gedächtnis. II. Die Veränderung der intraserialen Assoziationen im Vergessensprozess. *Z. Psychol.* 176:1–21
135. Ibid. III. Ein stochastisches Operatormodell zur Beschreibung serialer Lernprozesse, 157–81
136. Lashley, K. S. 1951. *Cerebral Mechanisms in Behavior*, ed. L. A. Jeffress, 112–36. New York: Wiley
137. Laughery, K. R. 1969. See Ref. 17, 135–200
138. Lee, W. 1966. Conditioning parameter model for reinforcement generalization in probabilistic discrimination learning. *J. Math. Psychol.* 3:184–96
139. Levine, G., Burke, C. J. 1972. *Mathematical Model Techniques for Learning Theories.* New York: Academic. 288 pp.
140. Lovejoy, E. 1966. Analysis of the overlearning reversal effect. *Psychol. Rev.* 73:87–103
141. Lovejoy, E. 1968. *Attention in Discrimination Learning, a Point of View and a Theory.* San Francisco: Holden-Day. 135 pp.
142. Luce, R. D. 1964. See Ref. 31, 380–98
143. Lynn, E. 1969. A stimulus sampling model for simultaneous discrimination learning. *J. Math. Psychol.* 6:277–85
144. Marley, A. A. J. 1967. Abstract one-parameter families of commutative learning operators. *J. Math. Psychol.* 3:414–29
145. Massaro, D. W. 1969. A three state Markov model for discrimination learning. *J. Math. Psychol.* 6:62–80
146. Massaro, D. W. 1970. Perceptual processes and forgetting in memory tasks. *Psychol. Rev.* 77:557–67
147. McGregor, J. R., Zidek, J. V. 1965. A sequence of limiting distributions of response probabilities. *Psychometrika* 30:491–97
148. Meyer, D. E. 1970. On the representation and retrieval of stored semantic information. *Cogn. Psychol.* 1:242–99
149. Millward, R. B. 1964. An all-or-none model for noncorrection routines with elimination of incorrect responses. *J. Math. Psychol.* 1:392–404
150. Millward, R. B. 1969. Derivations of learning statistics from absorbing Markov chains. *Psychometrika* 34: 215–32
151. Minsky, M., Papert, S. 1969. *Perceptrons.* Cambridge, Mass.: MIT. 258 pp.
152. Mott, T. H. Jr., Ross, B. M. 1968. An application of truth functional logic to concept-attainment experiments. *J. Math. Psychol.* 5:470–95
153. Murdock, B. B. Jr. 1967. Theoretical note: A fixed-point model for short-term memory. *J. Math. Psychol.* 4:501–6
154. Murdock, B. B. Jr. 1970. See Ref. 160, 285–304
155. Myers, J. L. 1970. *The Psychology of Learning and Motivation, Advances in Research and Theory*, ed. G. H. Bower, 4:109–91. New York: Academic. 339 pp.
156. Nahinsky, I. D. 1967. Statistics and moments-parameter estimates for a duoprocess paired-associate learning model. *J. Math. Psychol.* 4:140–50
157. Nahinsky, I. D. 1970. A hypothesis sampling model for conjunctive concept identification. *J. Math. Psychol.* 7:293–316
158. Neimark, E. D., Estes, W. K. 1967. *Stimulus Sampling Theory.* San Francisco: Holden-Day. 681 pp.
159. Nilsson, N. J. 1965. *Learning Machines.* New York: McGraw-Hill
160. Norman, D. A. 1970. *Models of Human Memory.* New York: Academic. 537 pp.
161. Norman, D. A., Rumelhart, D. E. 1970. See Ref. 160, 21–66

162. Norman, M. F. 1964. See Ref. 31, 173–87

163. Norman, M. F. 1966. An approach to free-responding on schedules that prescribe reinforcement probability as a function of interresponse time. *J. Math. Psychol.* 3:235–68

164. Norman, M. F. 1966. Limiting distributions for some random walks arising in learning models. *Ann. Math. Statist.* 37:393–405

165. Norman, M. F. 1968. On the linear model with two absorbing barriers. *J. Math. Psychol.* 5:225–41

166. Ibid. Some convergence theorems for stochastic learning models with distance diminishing operators, 61–101

167. Ibid 1970. Limit theorems for additive learning models. 7:1–11

168. Ibid 1971. Slow learning with small drift in two-absorbing-barrier models. 8:1–21

169. Norman, M. F., Graham, N. V. 1968. A central limit theorem for families of stochastic processes indexed by a small average step size parameter, and some applications to learning models. *Psychometrika* 33:441–50

170. Norman, M. F., Yellott, J. I. Jr. 1966. Probability matching. *Psychometrika* 31:43–60

171. Olson, G. M. 1968. *Stanford Univ. Inst. Math. Stud. Soc. Sci. Tech. Rep. 131*

172. Parks, T. E. 1966. Signal-detectability theory of recognition-memory performance. *Psychol. Rev.* 73:44–58

173. Peterson, L. R., Hillner, K., Saltzman, D. 1962. Time between pairings and short-term retention. *J. Exp. Psychol.* 64:550–51

174. Peterson, L. R., Peterson, M. J. 1959. Short-term retention of individual verbal items. *J. Exp. Psychol.* 58:193–98

175. Polson, M. C., Restle, F., Polson, P. G. 1965. Association and discrimination in paired-associates learning. *J. Exp. Psychol.* 69:47–55

176. Polson, P. G. 1970. Statistical methods for a general theory of all-or-none learning. *Psychometrika* 35:51–72

177. Polson, P. G., Greeno, J. G. 1969. Nonstationary performance before all-or-none learning. *Psychol. Rev.* 76:227–31

178. Popper, K. R. 1959. *Logic of Scientific Discovery*. New York: Basic Books. 480 pp.

179. Posner, M. I., Mitchell, R. F. 1967. Chronometric analysis of classification. *Psychol. Rev.* 74:392–409

180. Prokasy, W. F., Harsanyi, M. A. 1968. Two-phase model for human classical conditioning. *J. Exp. Psychol.* 78:359–68

181. Prokasy, W. F., Kumpfer, K. 1969. One- and two-operator versions of a two-phase model applied to the performances of Vs and Cs in human eyelid conditioning. *J. Exp. Psychol.* 80:231–36

182. Regnier, S., Rouanet, H. 1968. *Calcul et Formalisation dans les Sciences de l'Homme*, 201–24. Paris: Centre Nat. Rech. Sci.

183. Reitman, J. S. 1970. See. Ref. 160, 117–48

184. Reitman, W. R. 1965. *Cognition and Thought*. New York: Wiley. 312 pp.

185. Restle, F. 1962. The selection of strategies in cue learning. *Psychol. Rev.* 69:329–43

186. Ibid 1964. A cognitive interpretation of intensity effects in stimulus generalization. 71:514–16b

187. Restle, F. 1964. See Ref. 31, 116–72

188. Restle, F. 1965. The significance of all-or-none learning. *Psychol. Bull.* 62:313–24

189. Restle, F. 1970. Theory of serial pattern learning: Structural trees. *Psychol. Rev.* 77:481–95

190. Restle, F., Brown, E. 1970. See Ref. 155, 249–332

191. Restle, F., Greeno, J. G. 1970. *Introduction to Mathematical Psychology*. Reading, Mass.: Addison-Wesley. 371 pp.

192. Richard, J. F. 1967. See Ref. 117, 135–49

193. Rock, I. 1957. The role of repetition in associative learning. *Am. J. Psychol.* 70:186–93

194. Rouanet, H. 1967. See Ref. 117, 113–28

195. Rouanet, H. 1967. *Les modèles stochastiques d'apprentissage*. Paris: Gauthier-Villars. 260 pp.

196. Rouanet, H., Ackerman, W., Iff, M., Bartz, A., Dupas, J. 1967. Épreuve de l'hypothèse d'acquisition par tout-ou-rien dans une expérience d'apprentissage de couples. *Année Psychol.* 67:409–41

197. Rumelhart, D. E. 1970. A multicomponent theory of the perception of briefly exposed visual dis-

plays. *J. Math. Psychol.* 7:191–218
198. Samuel, A. L. 1963. See Ref. 77, 71-108
199. Selfridge, O. G. 1959. *The Mechanization of Thought Processes*, ed. D. V. Blake, A. M. Uttley, 511–29. London: Her Majesty's Stationary Office
200. Selfridge, O. G., Neisser, U. 1963. See Ref. 77, 237–50
201. Shepard, R. N., Teghtsoonian, M. 1961. Retention of information under conditions approaching a steady state. *J. Exp. Psychol.* 62: 302–9
202. Shiffrin, R. M. 1970. See Ref. 160, 375–447
203. Shiffrin, R. M., Atkinson, R. C. 1969. Storage and retrieval processes in long-term memory. *Psychol. Rev.* 76:179–93
204. Simon, H. A., Kotovsky, K. 1963. Human acquisition of concepts for sequential patterns. *Psychol. Rev.* 70:534–46
205. Smallwood, R. D. 1971. The analysis of economic teaching strategies for a simple learning model. *J. Math. Psychol.* 8:285–301
206. Sperling, G. 1960. The information available in brief visual presentation. *Psychol. Monogr.* 74:1–29
207. Spiker, C. C. 1970. An extension of Hull-Spence discrimination learning theory. *Psychol. Rev.* 77:496–515
208. Steiner, T., Greeno, J. G. 1969. An analysis of some conditions for representing N state Markov processes as general all-or-none models. *Psychometrika* 34:461–87
209. Sternberg, S. 1966. High-speed scanning in human memory. *Science* 153:652–54
210. Suppes, P. 1969. Stimulus-response theory of finite automata. *J. Math. Psychol.* 6:327–55
211. Suppes, P. 1969. Stimulus-response theory of automata and TOTE hierarchies: A reply to Arbib. *Psychol. Rev.* 76:507–10
212. Suppes, P., Atkinson, R. C. 1960. *Markov Learning Models for Multiperson Interactions.* Stanford Univ. Press. 296 pp.
213. Suppes, P., Donio, J. 1967. Foundations of stimulus-sampling theory for continuous-time processes. *J. Math. Psychol.* 4:202–25
214. Suppes, P., Ginsberg, R. 1963. A fundamental property of all-or-none models, binomial distribution of responses prior to conditioning, with application to concept formation in children. *Psychol. Rev.* 70:139–61
215. Suppes, P., Groen, G., Schlag-Rey, M. 1966. A model for response latency in paired-associate learning. *J. Math. Psychol.* 3:99–128
216. Theios, J. 1963. Simple conditioning as two-stage all-or-none learning. *Psychol. Rev.* 70:403–17
217. Theios, J. 1965. The mathematical structure of reversal learning in a shock-escape T-maze: Overtraining and successive reversals. *J. Math. Psychol.* 2:26–52
218. Theios, J. 1968. Finite integer models for learning in individual subjects. *Psychol. Rev.* 75:292–307
219. Theios, J. 1971. *Aversive Conditioning and Learning*, ed. F. R. Brush, 297–346. New York: Academic. 626 pp.
220. Theios, J., Brelsford, J. W. Jr. 1966. A Markov model for classical conditioning: Application to eyeblink conditioning in rabbits. *Psychol. Rev.* 73:393–408
221. Theios, J., Brelsford, J. W. Jr. 1966. Theoretical interpretations of a Markov model for avoidance conditioning. *J. Math. Psychol.* 3:140–62
222. Thomas, H. B. G. 1968. An information-theoretic model for the serial position effect. *Psychol. Rev.* 75: 409–20
223. Timpe, K. P. 1965. Einige Probleme der systemtheoretischen Analyse sensomotorischer Lernvorgänge. *Z. Psychol.* 171:400–9
224. Timpe, K. P. 1966. Die Beschreibung einfacher Trackingleistungen mit Hilfe eines zeitoptimalen Porzesses. *Elek. Inform. Kyber.* 2:107–19
225. Timpe, K. P. 1971. *Visual Information Processing and Control of Motor Activity*, 523–25. Sophia: Bulgarian Acad. Sci.
226. Trabasso, T., Bower, G. 1964. Component learning in the four-category concept problem. *J. Math. Psychol.* 1:143–69
227. Ibid 1966. Presolution dimensional shifts in concept identification: A test of the sampling with replacement axiom in all-or-none models. 3:163–73
228. Trabasso, T., Bower, G. H. 1968. *Attention in Learning: Theory and Research.* New York: Wiley. 253 pp.

229. Trabasso, T., Rollins, H., Shaughnessy, E. 1971. Storage and verification stages in processing concepts. *Cogn. Psychol.* 2:239–89

230. Uhr, L., Vossler, C. 1963. See Ref. 77, 251–68

231. Underwood, B. J. 1964. See Ref. 67, 47–78

232. Underwood, B. J., Schulz, R. W. 1960. *Meaningfulness and Verbal Learning*. New York: Lippincott. 430 pp.

233. Vitz, P. C., Todd, T. C. 1967. A model of learning for simple repeating binary patterns. *Psychol. Rev.* 75:108–17

234. Warburton, D. M., Greeno, J. G. 1970. General shape function model of learning with applications in psychobiology. *Psychol. Rev.* 77:348–52

235. Waugh, N. C., Norman, D. A. 1965. Primary memory. *Psychol. Rev.* 72:89–104

236. Waugh, N. C., Smith, J. E. K. 1962. A stochastic model for free recall. *Psychometrika* 27:141–54

237. Wickelgren, W. A. 1970. See Ref. 160, 67–102

238. Wickelgren, W. A., Norman, D. A. 1966. Strength models and serial position in short-term recognition memory. *J. Math. Psychol.* 2:316–47

239. Wickens, T. D., Millward, R. B. 1971. Attribute elimination strategies for concept identification with practiced subjects. *J. Math. Psychol.* 8:453–80

240. Wolford, G. 1971. Function of distinct associations for paired-associate performance. *Psychol. Rev.* 78:303–13

241. Wolford, G., Bower, G. H. 1969. Continuity theory revisited: Rejected for the wrong reasons? *Psychol. Rev.* 76:515–18

242. Wolter, D. G., Earl, R. W. 1969. The asymptotic values of response probabilities in the Audley-Jonkheere learning model. *Psychometrika* 34:203–14

243. Young, J. L. 1971. Reinforcement-test intervals in paired-associate learning. *J. Math. Psychol.* 8:58–81

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STUDENT DEVELOPMENT AND COUNSELING

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Several criteria have guided our selection of publications for review. With rare exception, we have included reports published during 1970–71 of avowedly psychological and empirical research on more than a single case. The topic of research is either counseling, the people who engage in it (e.g. as counselor or client), or both. Rare exception is exemplified by articles in professional journals containing the words "counselor" or "counseling" in their titles. If the *Journal of Counseling Psychology* is disproportionately represented, it is because the bulk of exhibits meeting the above criteria were published there. Alternative criteria of selection must be at least as arbitrarily imposed. As will become evident, counseling is the label attached to a conglomerate of activities that otherwise have little in common with each other. To identify counseling further as a helping activity is simply to align it with a host of events with other labels (e.g. therapy, social service, education, the ministry, the law, etc). In that students are most often designated as the recipients of counseling, their "development" is also considered. Two years ago, student development research was extensively covered, with proportionately less space devoted to counseling (81). Again, we have arbitrarily partitioned our review into publications on counselor role, paraprofessionals, clients, and process-outcome research. Some topical overlap is inevitable.

COUNSELOR ROLE

In sociological usage, a profession is "a high-status occupation composed of highly trained experts performing a very specialized role in society" (140). Many traditional roles of this sort are presently being challenged and modified, however, under pressure from dissident groups operating within as well as outside of professional organizations. Whether all who call themselves counselors could legitimately claim expert status or even want to, the identification of counseling as a profession has long preoccupied many persons. For them, the definition of counselor role has been an attendant concern. Because or in spite of impetus toward redefinition, counselor role continues to be a topic of considerable interest.

During 1970–71, for example, five surveys relating to this topic were reported (1, 7, 56, 114, 157). These were in the pattern of research conducted by Warman in the early 1960s (151, 152); in two of the recent studies, his instruments and procedures were used with but slight modification (114, 157). Although there are some differences in results obtained from the earlier and later surveys, similarities in the two sets of findings are the more striking. Warman found that counselors identified personal adjustment problems as the most appropriate type for clients to present in counseling. Other campus groups—students, faculty members, and other student personnel workers—had different ideas. Ten years later, counselor priorities were unchanged and still different from those of others in the university community. Wilcove & Sharp (157) found that students, unless they had had previous experience with the counseling center, rated problems of handling college routine as most appropriate, vocational development problems next, and finally those of personal adjustment. Resnick & Gelso (114) discovered that although all groups sampled viewed "adjustment to self and other" problems as more acceptable for counseling center personnel to deal with than did groups surveyed a decade earlier, counselors still rated these problems as more appropriate than did any of the other groups.

Harman (56) developed a questionnaire in which former clients were asked to evaluate the services they received. The evaluation form was based on the Missouri Diagnostic Classification plan (23). In response, the former clients diagnosed their problems as follows: vocational (58%), personal (29%), and educational (13%). But when asked the cause of these problems, 44% of the clients identified lack of information about self and 34% indicated conflict within self. It seems plausible to assume that many counselors would interpret the latter kinds of troubles as personal problems. Clients and counselors, at least, may not differ markedly in their ideas of problems to be solved through counseling. This view of things is further supported by the findings of Wilcove & Sharp (157), as reported above.

However, the discrepancy remains between what counselors think they do and what nonclients regard as appropriate for counseling. For example, Bartlett & Thompson (7) found a discrepancy in perception at the high school level comparable to that revealed at the college level (114, 151, 152, 157). By means of a semantic differential technique, counselors' and superintendents' perceptions of counselor performance in 11 skill areas were compared. Although there was considerable agreement between the two groups over the counselors' preparation and qualifications, there was disagreement on how well the counselors were prepared to handle "personal-social" counseling. Superintendents rated the counselors as less well prepared in this area than counselors rated themselves. According to the authors, counselors believed that in the personal-social area "they received their best training or at least view it as their primary and most important function."

Anderson's (1) survey compared 219 college or university counseling centers on the basis of institution size and services offered. The number of services offered did not vary much in terms of the size of the institution, but there were notable differences in kind of services offered. Larger schools were more likely to offer long-term therapy for emotional problems and to extend thier services to nonstudents. Smaller schools were more likely to offer programs not directly related to counseling, such as a student loan service. The major areas of agreement in services offered across schools regardless of size were: (*a*) counseling for personal problems, 96%; (*b*) counseling for study problems, 92%; and (*c*) counseling for choice of major field, 91%. These results reported by counselor center directors are consistent with those from the other surveys reported. Counselors, in high school and college or university settings at least, perceive their main responsibility to be one of counseling with clients who have personal problems. This assessment is not always shared by others, particularly faculty and others in the community who are likely to be in a position to refer clients.

All of these surveys indicate a generally conventional view of the counselor's role in educational settings. For example, Anderson (1) reports that few schools added much to his list of 30 services. Additions of interest included "special testing programs such as screening campus police" (6 schools reporting), and "special programs for disadvantaged" (3 schools reporting).

From the reviewers' perspective, an adequate consideration of the role of the counselor must include the question of ethics. More attention has been devoted to this topic in the last several years, but this has not generated questions amenable to empirical test. Long & Impellitteri (85) edited a special edition of the *Personnel and Guidance Journal* with 16 articles, none of which was empirical.

Two discussions of counselor role from an ethical-philosophical point of view deserve mention here—those of Lowe (86) and Gelso (43). Though not empirical, these are thoughtful contributions from which ideas might be incorporated into the design of process/outcome studies. Lowe (86) asks serious questions about professional help, its moral implications, and the treatment values of the counselor. Lowe presents four dominant conflicting value models or roles assumed by contemporary counselors: humanistic, naturalistic, social, and existential. He views the counselor as a new source of moral authority (a view no doubt rejected by many counselors yet nonetheless acted upon; see Counseling as Behavior Modification) but at the same time believes the task of the counselor to be one of helping the client to achieve personal freedom. Gelso (43) goes to the heart of the determinism-free will issue and its relation to the counselor as scientist-practitioner (106). The counselor must somehow resolve a central human dilemma—whether a person need view himself as subject or object so as to become an internally consistent individual. Solution in the ascientific direction of free will results in a different view of the counseling process, and the counselor's role in it, than a solution in favor of determinism. Gelso suggests a way out of the dilemma by stating that "subjectively experienced freedom serves as a critical determinant of human behavior," and cautions against counselors' accepting a behavior model formed solely from either extreme on the free will-determinism continuum.

Pepinsky (103) earlier questioned the ethics of indiscriminate behavior modification and other forms of social intervention. For instance, if a therapist acts deliberately to alter the behavior of person A for the sake of person B, he may be placing himself in an ethically indefensible position. Ullmann (148), who cites this argument, indicates that such intervention often occurs in child therapy, work with retardates, and correctional procedures with criminals and hospitalized schizophrenics. And he further states that the counselor is on ethically difficult grounds "whenever a change in the person receiving therapy will have an effect on another person."

Such discussions (43, 75–77, 86, 103, 14[illegible]) pose important issues about power, influence, and control in counseling, along with the delicate ones of when the professional counselor may be taking too much for granted about what is good for other persons and when he is legitimately entitled to exercise his special knowledge on their behalf. Work in behavior modification has made these issues especially prominent (e.g. 77), but as yet few empirically answerable questions related to them have been asked. And with rare exception (89, 103–105), prior epistemological questions, such as how we are to know when psychological treatment of any kind his been "effective" or "successful," are never even raised.

TRAINING

Arbuckle (4) argues that one's view of appropriate counselor education is directly related to one's model of man. Again, however, research on counselor training during the period covered by this review is based less on important philosophical considerations about man and more on how to teach techniques or procedures that are assumed to produce "effective counselors." Often these assumptions, if stated at all, are unwarranted; much of the research itself suffers from lack of careful conceptualization about what is involved in counseling and training. Hansen & Warner (55), in their thoughtful review of research on practicum supervision, indicate further that the experimental designs of most studies need refinement before important claims about training may be considered to be supported by empirical evidence. There are many questions about training that need to be articulated in this fashion. These include the role of supervision, the methods of supervision and training, the effects of these methods on the trainee, and his subsequent participation as a counselor in the counseling process. Although more rigorous conceptualization is needed, there have been many exploratory studies concerned with this topic, and professional interest seems high. Much of this research has been pre-experimental or correlational in design (24). Hansen & Warner (55) also found this to be the case in articles on practicum training from 1960–1969, which they reviewed.

Many studies suffer from recourse to questionable measurement constructs or instruments. Sometimes trainee performance is measured in terms of criteria, e.g. self-report, that have not been as yet clearly related to counseling process and outcome. Often, too, the experimental treatment is vaguely defined. Some of these studies will be reviewed briefly to indicate the status of research on training and problems suggested by it that seem to merit further consideration.

Myrick & Pare (97) investigated the effects of group sensitivity training within a counselor education program. They employed a control group and a pre-posttest design. It was hypothesized that participation in the group experience would have a positive effect on participant self-concept and increase his effectiveness in offering the much heralded "core dimensions" of empathy, warmth, and genuineness during counseling. Measures used were the Tennessee Self-Concept

Scale (39) and judges' ratings of audiotape excerpts from a counseling session in which the subject served as counselor (Truax scales, 142). Since there were no significant differences between experimental and control subjects, the hypothesis was not supported.

Monke (94) investigated the use of systematic desensitization to reduce the anxiety of beginning counselors before their first interview. Subjects were members of an NDEA institute and were randomly assigned to a treatment or control group. The study utilized a posttest design in which dependent measures were self-report, tape evaluation, and physiological measures. The experimental treatment consisted of two sessions of body relaxation followed by five sessions of desensitization to a level of anxiety manifested in the first interview. Results indicated no significant differences on tape evaluations or physiological measures. Only in its self-reports did the experimental group reveal significantly less anxiety than control subjects.

Both this study (94) and one by Mazer & Engle (87) raise the question of "placebo effect" in counselor training. Mazer & Engle (87) investigated attitude change on the part of counselor trainees. Pre-posttest measures were administered to an "experimental" group, i.e. members of a 38-week Guidance Institute designed to prepare secondary counselors to work with disadvantaged youth, and a "control" group composed of students enrolled in the regular counselor education program. Dependent measures were the Personal Orientation Inventory (POI, 128) and a semantic differential (SD) technique. There were no changes in the SD scores of subjects in the experimental group; they viewed disadvantaged children and their parents much the same after as before the institute. However, the experimental group changed more, and from the researchers' viewpoint in a positive direction, on selected scales of the POI. Though both groups made "substantial gains toward self-actualization . . . larger gains were registered by the experimentals in every category." Differences in amount of gain for each scale were statistically significant on two scales: existentiality and feeling reactivity. Both sets of results (87, 94) are easily accounted for in terms of placebo effect: when individuals receive special treatment and attention, their feelings about themselves and the situation are apt to become more positive. More critically, neither study indicates that "experimental" treatment has modified trainee attitudes toward or performance in counseling. Monke's (94) "desensitized" subjects were not shown to manifest any less anxiety during counseling, and Mazer & Engle's (87) subjects in the special training institute did not change their attitudes toward the clientele they supposedly had been prepared to serve.

A correlational study by Bishop (11) emphasizes the need for caution in drawing inferences from ratings provided by those who have undergone psychological treatment of any kind (105). Bishop (11) compared counselors', supervisors', and clients' ratings of counselor effectiveness; the instrument was the Counseling Evaluation Inventory (CEI), which uses client satisfaction as a criterion (84). The clients' CEI ratings were significantly higher than either the counselors' self-ratings or ratings by their supervisors. As in the above studies (87, 94), these results may be attributed to "placebo effect" as much as to intended treatment. It is interesting to note that supervisors' and counselors' ratings were significantly correlated with each other but not with those of the clients.

Brown (17) indicates that counselors, too, may be subject to placebo effect. In a correlational study of the relationship between counselors' first impressions of clients and case outcome, he used both experienced and inexperienced counselors and correlated five first impression variables with five outcome variables. Though most of these correlations are moderately low, there were significant correlations between (*a*) both experienced and inexperienced counselors' personal liking for the client and their view of their own success with the client and (*b*) experienced counselors' early assessment of the client's potential for change and their eventual view of their own success with the client. Brown legitimately asks whether these results are indicative of wish fulfillment and whether they should be used in making counselor-client assignments. As Brown notes, "if liking has an impact on [counselors'] . . . effectiveness, they should be aware of it and respond appropriately."

Counselor trainers are often interested in personal characteristics related to effective counseling. Both "personal characteristics" and "effective counseling" are difficult terms to pin down, and are usually defined quite arbitrarily by the investigator for the purpose of his research. Milliken & Kirchner (93) conducted a correlational study (analysis of variance by linear regression) to explore the relationships of a counselor's perceptual defense to his recall of interview content. Thirty-nine graduate student counselor trainees who participated as subjects watched videotaped simulations of each of four counseling sessions. The client was an actor who portrayed a different emotion in each session. The emotions were anger, anxiety, positive affect, and normality. After viewing each tape, subjects were tested for recall by both objective and open-ended measures. These results were compared with the counselors' scores on the IPAT Anxiety Scale Questionnaire. There were no significant relationships between the anxiety and open-ended recall scores, but there was a significant relationship between the anxiety and overall objective test score. The video role of anger (depicted as directed toward the counselor) elicited these combined results most clearly, with the normal role also contributing significantly. These findings have implications for training, particularly for assessing a potential counselor's ability to be aware of what takes place between him and an angry client. Replication of the study with experienced counselors is also indicated, since they are presumably better able to take account of what happens in an interview than inexperienced ones. An experienced counselor's open-ended recall score thus may be the more clearly related to his perceptual defense and other dispositional attributes.

Another study related to counselor characteristics is reported by Eberlein & Park (32). This was a correlational study of the relationship between self-concept and ideal self-concept congruence and final performance measures for counselors undergoing training in a practicum setting. Although a curvilinear relationship is indicated, there is need for extreme caution in interpreting the results. There are no validation data to support claims made for the instrument (Counselor Practicum Evaluation Form) used by the supervisors to rate counselor effectiveness. In addition, the results are spotty. For example, the curvilinear relationship was found for men but not for women, and for day students but not for night students. It is also not clear what criteria were used by the supervisors in determining whether counseling was effective. Areas in which they rated the clients were: (*a*) ability to establish effective counseling relationships; (*b*) ability to assume professional responsibility; (*c*) interest, effort, and sincerity; (*d*) interpersonal relationships with staff; and (*e*) overall competence.

In 1965, Schmidt & Pepinsky (121) observed that use of videotape "seems to hold considerable promise for counseling research despite the expense and continued technical problems encountered in videotaping and kinescoping." Some of the finest research in this area has since been reported by Kagan and his associates (25, 68–70, 115). The two primary videotape programs developed by this group are that for Interpersonal Process Recall (IPS: 68, 70, 71) and Video Tape Recall of Affect Simulation (VRAS). In VRAS, clients are confronted with films which encourage them to engage in simulated interpersonal relationships. While the client is viewing the film, both he and the film are videotaped. The videotape is then played back to the client in the presence of his counselor who helps him examine his reactions to the film. Interpersonal Process Recall consists of a counseling session that is videotaped and a recall session where a clinically trained third person or "interrogator" helps the client to examine the dynamics of his interaction with the counselor. The purpose of the technique is to accelerate client insight and change during counseling. Often the two techniques are combined to accelerate the process of client confrontation with his own expressed feelings. Research on these programs was initially designed to "determine the effectiveness of a specific method of using video-technology for the solution of a variety of counselor education and teaching-learning problems (69)." Work has progressed to such an extent that the techniques and their variations have been a rich source of information about counseling and other interpersonal relationships. Instruments applicable to both counseling and counselor training have been developed.

One such instrument has recently been described by Campbell, Kagan & Krathwohl (25). They report progress on the development and validation of a scale to test one's ability "to detect and identify the immediate affective state of another (affective sensitivity)." Subjects view videotaped excerpts from actual counseling sessions, and immediately afterward are asked to indicate the client's feelings by selecting one sentence from among three presented in a multiple choice format. There are several items for each counselor scene; in this report the revised instrument contained 89 items. Although further refinements are planned, the scale shows promise of becoming a valuable aid in counselor training and selection. As the authors point out, however, it may predict failures better than successes; e.g. having empathy with a videotaped client does not necessarily mean knowing how to employ it in a counseling relationship.

There have been other uses of videotape techniques in counselor training (37, 158). Yenawine & Arbuckle (158) examined the records of two groups of trainees and their supervisor in relation to their practicum experiences. One group was exposed to audiotaped playback of their interviews while the other had recourse to videotape. Measures used were self-reports and supervisor evaluations. The results indicate that after some initial anxiety on the part of the trainees about seeing themselves on videotape, trainees and supervisors both agreed that the videotaped feedback was superior to that from audiotape. The videotaped feedback group seemed to be more insightful about and aware of the nuances of human interaction and seemed more open to self-disclosure and self-examination. Although the sample is limited and the results are tentative, videotaped feedback seems useful in focusing practicum discussion on counselor behavior instead of client behavior, and it provides a more complete record for discussion purposes. However, the authors note that this kind of feedback week after week can become "like television viewing, a very passive and uninvolving experience." This is an important consideration in supervision programs of long duration. Videotape, like any didactic technique, may need to be used strategically if it is to continue to have a desired impact upon its viewers.

English & Jelenevsky (37) drew somewhat different conclusions from their work. Theirs was a correlational study which investigated the reliability of the counselor evaluation process in relation to a communication stimulus. Judges were six first-year graduate students from a rehabilitation counselor education program, who rated counselor empathy from vignettes of counseling sessions presented to them by means of three media: audio, visual, and audiovisual. The measure of counselor empathy was Carkhuff's (26) Empathetic Understanding in Interpersonal Process scale. When used by judges trained in the use of the scale, there was significant interrater reliability, yet no one medium produced distinctly higher reliability ratings. The authors interpret these results to mean that claims for the superiority of audiovisual tapes in counselor education evaluation are not substantitated. Limitations of this research are that (*a*) the investigators may not be asking the right questions about how to use audiovisual technology in training, and (*b*) first-year graduate students may not qualify as bonafide supervisors.

A well-designed experimental study (38) assessed the effect of four treatment conditions upon subjects' responses to client statements. The clients were actors and their comments were prepared from typescripts and audiotapes of actual counseling sessions. Responses to be elicited were identified as "counseling tacting responses leads," which in translation implies counselor statements that would evoke desired responses from the client. Each group viewed 40 videotaped excerpts. Experimental groups included subjects who received (*a*) modeling only, (*b*) reinforcement only, and (*c*) modeling and reinforcement; there was also a (*d*) no-treatment control group. Subjects under the modeling-only condition observed an "expert counselor" in the tape with the first 20 clients. This counselor followed each client's statement with a prerehearsed "tacting response lead." Subjects themselves made no response during these first 20 client presentations. During the second 20 presentations, however, the client appeared alone, and subject was asked to give appropriate rejoinders to each of the client statements. Under the reinforcement only condition, subjects were asked to respond to all 40 frames on the tape. In frames 1–20, subjects were reinforced by verbal approval from the experimenter (E) whenever they emitted a "verbal tacting operant." Under the modeling-reinforcement condition, procedures for frames 1–10 were like those of modeling-only group. However, procedures for 11–20 were like those of the reinforcement-only condition. Frames 21–40 were the same across all three treatment conditions. Responses of the subjects to client frames 21–40 served as a dependent variable. Subjects' statements were scored by two raters who were not counseling students but had been trained for the purpose. A "transfer" counseling session, which consisted of a live interview between a subject and volunteer "client," was conducted by all three treatment groups plus the no-treatment control group. Although there seemed to be differential effects upon the transfer situation itself, the most important finding was that the modeling procedures had the greatest effect on subjects' responses to client statements 21–40 on the videotape. This type of study bears replication, perhaps with the transfer condition lengthened to encompass several sessions.

The findings of Eisenberg & Delaney (34) concerning the importance of modeling in training are consistent with those of Pierce & Schauble in three investigations of training effects (107–109). In a well-designed correlational study (107) the investigators report that counseling interns who had supervisors rated as functioning at high levels, e.g. of empathy, positive regard, etc, changed significantly and positively on these dimensions. Those with supervisors at low levels declined slightly on these dimensions. The authors followed up these same subjects 9 months after the original research (108). Each subject was now asked to submit a current counseling tape to be evaluated by new judges who had not been connected with the previous research. With one exception (an increase in concreteness for the low group), the ratings remained unchanged and the high group retained its superiority on all four scales. Follow up reduces the likelihood that the earlier results could be attributed to supervisor popularity or to temporary identification with him. The same investigators (109) conducted a systematic replication with a new group of subjects, which also provides information about the effects upon a trainee of getting conflicting messages (in this case, from a high-level practicum instructor and a low-level individual supervisor). Results were similar to those of the earlier study and in general supported what the investigators had hypothesized. One surprising result was that subjects under the high-low condition gained on the rated dimensions, as did the high-high subjects after the first 10 weeks. Trainees in the high-low group either tended to model themselves after the high model or to drop out.

PARAPROFESSIONALS

As Layton, Sandeen & Baker (81) have noted, increased attention in counseling research is centered on "the use of peers or less than professionally trained persons to offer conditions of facilitative growth in others." Work in this area raises important questions about professional counseling and the training of counselors. Knowledge concerning the effectiveness of paraprofessional help could be enhanced by well-designed, multivariate, longitudinal studies; unfortunately, most of the current research can be classified as one-shot case studies (cf

24). Much of the work has compared the "therapeutic conditions" of therapist empathy, warmth, and genuineness (e.g. 14[illegible]) with various criteria of counseling effectiveness. The assumption underlying many of these investigations is that clients of therapists inferred to possess all three traits in high degree will demonstrate more improvement on the outcome measures than clients who do not have such therapists. However, not all studies indicate that the three traits correlate positively with one another (42, 144), which has caused Truax & Carkhuff (145) to modify their position by stating that in such a case "patient outcome is best predicted by whichever two conditions are most closely related to each other." Bordin (15) implies that such a modification represents an unsuccessful attempt to make contradictory data fit their view of counseling effectiveness. An additional problem is raised by Garfield & Bergin (42). Besides finding that the three traits did not correlate with one another (empathy and warmth correlated positively with one another but negatively with genuineness), these investigators found that these attributes may be appropriate only for rating the effectiveness of client-centered therapists. Garfield & Bergin (42) investigated the relationship of these dimensions to a variety of outcome measures, but the therapists were predominantly nonclient centered. Results were consistent and demonstrated a "complete lack of relationship between any of the three therapeutic conditions and any outcome variable."

Another problem with much of the paraprofessional research to date is that there has been no clear demonstration of the precise relationship between therapeutic conditions and counseling outcomes. It is often just as warranted to assume that factors other than those claimed by the investigators are accounting for the results. For example, Truax & Lister (146) in a quasi-correlational study (employing an ANOVA 3×2 factorial design) compared the effectiveness of counselors and counselor aides in working with rehabilitation clients. Counselors were rehabilitation counselors, trained at the master's level, and aides were recruited from secretary applicants. The investigation was conducted over a 14-month period, and the four counselors and four counselor aides worked with 168 clients. Aides were judged superior on the basis of ratings of client progress made by training supervisors. However, measures upon which these ratings were made had not been validated empirically. In addition to methodological problems such as the use of a nonvalidated instrument, McArthur (88) and Sieka et al (129) pose some very important issues about what could account for the results.

Issues raised include placebo effect; it is probable that this must be accounted for any time a new person comes to a new job. This seems especially important since the experienced counselors were assigned and the aides recruited from those who applied. Also, groups were not matched on other variables such as sex and age, which factors could have enhanced the placebo effect and have influenced counseling outcomes. Though placebo effect may be helpful in counseling, and seems to be capitalized upon by many professionals, it is not sufficient to account for what both client and counselor may do to achieve the results each desires. Sieka et al (129) make the additional point that a large amount of the effective rehabilitation counselor's time is spent as an advocate for the concerns of his client. Hence, measures of counselor effectiveness need to take account of counselor actions other than in the interview. Truax (143) takes issue with Sieka et al (129) on most counts. In cases of this kind, where counter-argument becomes heated when legitimate questions are raised and where contradictory evidence seems to have been waved aside, further research by other investigators is clearly indicated.

Other investigators have also studied the paraprofessional's effectiveness. A correlational study by Engelkes & Roberts (36) investigated the effect of different levels of academic training on the job performance of rehabilitation counselors. The criteria for job performance were supervisor's ratings and client satisfaction. Here, trained rehabilitation counselors were not seen to perform their jobs better than untrained ones. Katkin et al (71) in a pre-experimental design compared recidivism rates for mental hospital outpatients. They used two groups of female schizophrenics. A control group received no treatment, and the experimental group received personal intervention (phone calls, home visits, etc) from housewife volunteers. This group had a significantly lower recidivism rate, as measured by return to the hospital. Again, placebo effects must be assessed, since attention alone may be more desirable than no attention. Is this kind of intervention, however valuable to patients, to be described as counseling? Additional studies in this area could examine more carefully what it was that helped patients to stay out of the hospital, and in other ways help to determine how best to make use of nonprofessional assistance by energetic and supportive persons.

Carkhuff & Bierman (27) conducted an experimental study to determine the effects of training as a preferred mode of treatment for parents of emotionally disturbed children. They used four treatment groups and a control and compared the effects of the treatments on parents' responses to (*a*) "standard helpee stimulus expressions," (*b*) role playing with spouse, and (*c*) play sessions with children. Parents perceived themselves as more communicative with their children, but this subjective feeling did not transfer to their behavior in the play session with their children.

There may be occasions where paraprofessional efforts are as good as or superior to those of the professional counselor. Paraprofessional helping activities need to be investigated by solid research design, with treatments clearly delineated and outcome measures expanded. Besides longitudinal work, cross-validation and systematic replication studies are needed. Professionals need to respond to this research with openness and innovation in using its results to supplement their own efforts at helping others. Although paraprofessionals probably have an important role in direct services, research has not yet demonstrated when and how counselors are effective. Nor has research shown that counseling is simply a conversation between an empathic person and another who is in trouble.

CLIENTS

INTRODUCTION

Counselors are greatly concerned with who comes for help and why. Although counselors may have believed that they knew the answers to these questions, recent investigators seem to take much less for granted about the client and his needs. There is awareness that social conditions may have brought about changes in clients and that traditional questions and answers may no longer be applicable. There is still much talk and little research, but many professional counselors are reevaluating both clients and their needs.

CROSS-CULTURAL

Many clients today evidence sociocultural patterns that differ from those of most professional counselors, who have been characterized as white, middle-class, and achievement oriented. For this reason, serious questions have been raised about the ability of such counselors to establish rapport with certain client groups. Blacks of African descent are among the most concerned with this problem, critically discussed by Vontress (149). He believes that black and white hostility in the U. S. has reached an all-time high and that this hostility presents problems not only for black clients and white counselors, but also for a black-black relationship when the counselor is unable to project himself as black. Vontress divides persons of African descent (who live in the U. S.) into three subgroups on the basis of how each group perceives itself, responds to its disenfranchisement, and reacts to whites in American society. He views the establishment of common group membership as basic to rapport in counseling, and illustrates the kind of difficulties that counselors may encounter with each group. Other discussions relating to blacks and counseling may be found in the May 1970 issue of the *Personnel and Guidance Journal,* and in a 1970 issue of the *Counseling Psychologist* devoted to this topic. In another special issue of the *Personnel and Guidance Journal,* on "Counseling and the Social Revolution," Smith (130) declares that guidance in American education has not served the black community and that blacks should unite for liberation not guidance.

To date, a good deal of necessary rhetoric has been devoted to this topic. There will be much more, we anticipate, before minority group spokesmen can believe that they have been adequately heard in the USA and elsewhere. Research is scanty, mostly correlational and based on samples whose representativeness is not clear. For instance, Shappell, Hall & Tarrier (125), in a correlational study, compared ninth-grade male and female innercity and suburban youths on their perceptions of and concerns about the world of work. The innercity sample ($n=93$) was over 90% black and the suburban group ($n=93$) was 100% white. The measure used was the Hall Occupational Inventory (54). Differences on this instrument indicate that innercity youths were concerned with location and physical environment of the work setting and the time units in which their work was to be accomplished. In contrast, the suburban youths expected work to be a potential need satisfier and were concerned with opportunities for promotion, making friends, and becoming well known through their work. Members of each group seem to have absorbed from their environments a fairly realistic picture of what the world of work might hold for them.

Pallone, Rickard & Hurley (100) present rank order correlations for self-reported key figures in occupational choice for four different groups of subjects: black males, black females, white males, and white females. The subjects were

11th and 12th-grade students from four cities in New York state. All four groups listed someone who held the occupation as the key figure in their choice. And each group except the black males listed the same sexed parent as the second most important figure. The black males ranked mother and father as equally influential.

Criterion analysis was used by Hager & Elton (53) to compare the vocational interests, as measured by the Strong Vocational Inventory Blank, of black and white entering male freshman at Berea College. Both groups were from low income families. Whites were found to be more interested in physical sciences and the blacks in social service. Kuvlesky, Wright & Juarez (80) used a correlational method to compare the status projections of high school sophomores from three ethnic groups: Mexican American, black and Anglo. Open-ended questions were designed to elicit information concerning occupational expectancy, aspirations, and the like. Although there were many similarities in response among the three groups, there were also differences. For example, Mexican Americans felt least certain of attaining their expectations, black youths had higher educational goals, and Anglos reported the least incongruency between aspiration and expectation.

Other minorities are receiving attention in the counseling literature. The October 1971 issue of the *Personnel and Guidance Journal* is devoted to the special problems of American Indians, Puerto Ricans, and Mexican Americans. Members of these groups authored the issue. Here again, research has been slow to follow the initial expression of concern. Kuvlesky & Patella (79) did an exploratory correlation study with Mexican American high school sophomores from four Texas counties. They investigated the relationship between ethnicity and upward social mobility. The ethnicity index was a measure of the use of the Spanish and/or English language in selected settings. Upward mobility was measured through "cross-classification of respondents on similar measures of level of job aspiration and of main breadwinner's occupation." It was hypothesized that the degree of identification with the Mexican American subculture would be inversely related to upward social mobility." This prediction was not supported; all subjects were inferred to be upward mobile.

The largest minority and the most probable candidates for counseling are women. Research, most of it demographic or correlational, is just beginning to appear. Since the feminist movement has brought the problems of women into prominence, there has been an increasing number of articles during the last 5–10 years. Most of these are concerned with women's occupations and vocational development. Astin, Suniewick & Dweck (5) have published an annotated bibliography of research on women during the last 10 years which should be useful to the counselor who wants to become better acquainted with women's problems. Levitt (82) has reviewed the literature on the vocational development of professional women. In many instances, he notes, the results of this research are inconsistent, perhaps attributable to an unclear or inadequate definition of "career orientation." Also, many of the subjects in these studies were college women who had as yet little or no experience with marriage or regular employment. Problems of interpretation that arise when college women are used as subjects for these surveys are further illustrated by Harmon's (57) survey of career commitment in women. Although Harmon claims that women became committed to careers through motivation, not circumstances, this motivation seems to become manifest after entrance into college. At age 18, committed women did not have career plans significantly different from those who remained uncommitted. If career women become more accepted in our society, young women may become committed earlier. Watley & Kaplan (155) surveyed women who won National Merit Scholarships between 1956 and 1960, to determine their marriage and/or career plans. Eight-five percent of them planned a career of some sort, and all but 6% of these planned to combine career and marriage. Many of those who planned marriage and careers expressed problems related to being a woman. The conflict of a bright, well-educated young woman who plans marriage and a career was summarized well by one subject in the study: "We're much too frustrated trying to decide whether to act like men or women, never succeeding in doing either properly."

In a demographic survey, Harmon (58) asked entering college women what career choices they had considered in the past, at what age they had begun to consider them, and at what age, if any, they had ceased to do so. Overall, the early choices of these women were few and general. The most popular and persistent choice was housewife. After housewife, in terms of overall popularity, medical, social service, and verbal related occupations were considered by the largest number of women, with business and clerical-secretarial considered by the smallest number.

In a well-designed post hoc correlational study (5×2 multivariate analysis of variance design), Rose & Elton (118) found a significant interaction between occupational category and sex. Independent variables were Holland's (62) five occupational categories and sex. Dependent variables were 11 scale scores from Form C of the Omnibus Personality Inventory (28). The personality test scores were obtained when the students were freshmen; subjects were assigned by the investigators to the Holland occupational categories on the basis of their majors as graduating seniors. The data suggest that (*a*) men and women choosing the same occupation do *not* have similar personality test scores; (*b*) Holland's theory and test are more appropriate for men than for women; and (*c*) different vocational development theories are needed for men and women.

STUDENTS

These are still the largest source of clientele for the counseling psychologist. In the last 10 years, there have been numerous efforts to describe student characteristics. Three such studies will be reviewed here (16, 41, 119). All are essentially correlational.

Rossmann & Kirk (119) studied factors related to persistence and withdrawal among university students. Their population included all Letters & Science freshmen who entered the University of California at Berkeley in the fall of 1966. This group was divided into three categories: persisters, voluntary withdrawals, and failures. The categorization was based on first year grade point average and whether the students returned to campus in the fall of 1967. Subgroups were compared on the basis of School and College Ability Test (29) and Omnibus Personality Inventory (28) scores. Compared to the persisters, the voluntary dropouts had higher verbal ability and were more intellectually oriented; and, as one might expect, the voluntary dropouts had significantly higher SCAT scores than the failures.

Entering college students' preparation for self-regulation were explored by Bordin, Shaevitz & Lacher (16). Their instrument was a questionnaire sent to parents of all incoming students for the 1967–68 academic year. The questionnaire asked each set of parents to rate the amount of freedom they gave their son or daughter in several areas, and the amount of freedom they expected the university to allow the student in these same areas. Areas included travel, study time, sex, smoking, drinking, and educational-vocational decision making. As expected, parents claimed to exercise somewhat more control over their daughters than their sons. A somewhat unexpected result was that in the areas of sex, smoking, and drinking, parents expected the university to exercise more control than they themselves had. In general, parents claimed to allow their offspring less freedom than they would have on campus. The authors discuss implications for counseling with students who are making the transition from home to social environments that are largely unrestricted.

Freeman & Brubaker (41) compared personality characteristics of 54 of 69 students who during February 1970 participated in a demonstration at Ohio Wesleyan University with those of 54 students who did not participate. The instrument was the ubiquitous Personal Orientation Inventory (128). On 10 of the 12 scales there were significant differences, the demonstrators scoring in the direction of greater "self-actualization." In this sample the demonstrators are revealed, as the authors put it, to "bear a closer resemblance to the type of student our colleges and universities seek to develop."

PROBLEMS CLIENTS BRING

Over the years, considerable effort has been directed at diagnosing and categorizing problems that clients bring to counseling (14, 22, 23, 102, 116). College students are the most frequent sources of data thus categorized and of statistics on how many clients manifest each type of problem. Research of this sort continues; again, student samples are the primary source of data. Sharp & Marra (127) surveyed trends in client problems and other matters related to classification over an 8-year period at the University of Wyoming counseling center. The client sample was discovered to be similar to the student population on every variable assessed except age. More younger clients used the service than would be expected by chance. Using their data and those supplied by Duguid (31), the authors discovered a steady increase in emotional problems (10% in 1960 to 45% in 1968) and a less consistent but steady decrease in educational problems. The percentage of vocational problems remained fairly consistent (slightly more than 40% over the 8-year period). Although, as reviewed earlier (157), students on this campus perceived this center's services as most appropriate for vocational and educational problems, there was a marked increase in problems classified as emotional. Most of this increase was accounted for by men; the percentage of women with diagnosed emotional problems did not appear to change significantly.

Using a somewhat different approach, Houston (65) reviewed literature concerned with the sources and effects of psychological problems for college students. He also reviewed attempts to predict what individuals would be most vulnerable to or adversely affected by their problems. The studies he reviewed indicated the academic area to be the most consistent problem for students to manage. It is difficult, however, to distinguish between "academic" and "personal" problems. As Houston points out, anxiety seems related in a complicated fashion to academic achievement; it just may be that measures of psychological adjustment are better predictors of future academic performance than current academic performance. Research on client problems in the journals we sampled was almost exclusively devoted to what could be labeled as "academically" and "vocationally" related. Therefore, discussion of client problems will be confined to these two areas.

Client problems: Academic.—For a number of years, counseling centers and other university agencies have attempted various kinds of treatment programs for students who are either having academic difficulties or have been labeled as underachievers. Bednar & Weinberg (8) present an excellent critical review of research on 23 such programs. Their survey indicates treatment programs associated with improved academic performance to be (*a*) structured rather than unstructured, (*b*) lengthy rather than brief, (*c*) counseling used in conjunction with an academic studies program, (*d*) high in levels of therapeutic resources, and (*e*) appropriate to student needs. The authors also emphasize the importance of motivation; subjects who volunteer for such programs improve their grade point averages more than those who do not.

Gilbreath (44) compared the subsequent grade point averages of underachievers who responded to an offer of counseling and those who did not. Although neither group was counseled, respondents achieved significantly higher grades than nonrespondents. In a correlational study, Lin & McKeachie (83) used an analysis of covariance to demonstrate that significant differences in academic performance between extreme anxiety groups may be largely the result of differences in ability. However, the study habits of women students particularly were directly related to academic achievement, apart from college aptitude. An abridged version of the Brown-Holtzman (18) survey of study habits and aptitudes was used as a measure of study behavior.

In a quasi-experimental study, Beyer (10) deliberately attempted to raise freshman students' grade point average by introducing a placebo. He divided entering freshmen (n = 1451) into two groups. Group 1 members were told their actual predicted grade point averages. Members of Group 2 were also given a prediction, but this was abitrarily raised .4 of a point for each subject. Dependent variables were grade point averages obtained at the end of the first semester, withdrawal rate, failure rate, and number of units taken during the first semester. There were no significant differences between the two groups on any of the dependent measures.

In an experimental study, Merchenbaum & Smart (90) induced expectancy for academic improvement and found that subjects in the experimental group did better than controls in two of four required engineering courses. Subjects were borderline engineering students divided into three groups: (*a*) experimental, (*b*) attention control, and (*c*) no-treatment control. Contact was made with members of the first two groups (n = 12 for each), who were asked whether they wanted to take psychological tests. They were told that the results of these tests would place them in one of two categories: a "late bloomer" who could be expected to do better (Group 1) or a person for whom the tests would not predict success or failure (Group 2). One week after testing, subjects returned in mixed groups of eight to receive the "results," and then had a discussion with the counselor about good study habits. Three weeks later, the expectancy and no-prediction groups were sent letters that reinforced the expectancy manipulation. The letter reminded subjects of the group to which they belonged and of their test results. All three groups were also given attitude measures. Self-reports of the expectancy group were significantly different from those of the attention control (no prediction) and no-treatment control groups on such matters as believing that (*a*) the testing program had made them more confident and had helped them to realize they could do better, and (*b*) their chances for success on examitions had improved. For whatever reason, the induced expectancy groups improved attitudinally and academically.

In a second experimental study, Andrews (2) compared the effects of behavioral and client centered counseling on the academic marks and anxiety test scores of high school underachievers. He also used a no-treatment control. The behavioral counseling group was exposed to both desensitization and reinforcement. There was a significant reduction in the anxiety test scores of the behavioral counseling groups, but no significant differences in their academic marks. It is interesting to recall, by comparison, that the best designed of these studies (90) effected significant changes on both self-report and academic achievement measures.

Client problems: Vocational.—Vocational development, occupational counseling, and other matters related to the world of work have long been concerns of counseling psychologists. The period covered by this review was no exception. Besides producing the usual plethora of articles (some of which we have already reviewed in the clients/cross-cultural section above), the review period was highlighted by the appearance of a new *Journal of Vocational Behavior* and a self-administered, self-interpreted vocational counseling tool (63). It is possible that this instrument, designed for use by younger and older clients, will offer some relief to the counselor who is beset by his time. It would be impossible to do justice to this area and also leave space for other important topics. Hence, we have selected seven research studies which we believe to be representative. (Work on vocational development among minority groups has been reviewed above.) All are correlational; one is also experimental. Four either purport to be direct tests of Holland's theory (62) or draw upon his vocational classifications scheme.

In a well-designed correlational study, Bodden (13) studied the relationship of cognitive complexity to "appropriate" vocational choice. He used two measures to assess cognitive complexity and two to assess appropriate vocational choice. Subjects were divided into underclass and upperclass males and females. The only significant correlation was that between vocational cognitive complexity and congruent vocational choice for upperclass males.

Holland's postulate, that students tend to choose occupations congruent with their personality structures, received support in a study by Elton & Rose (35). The investigators classified each of 137 male graduating seniors into one of Holland's six vocational categories. Subjects were divided in each category into (*a*) vocationally undecided as freshman, (*b*) immigrants to the category, and (*c*) persisters who had been in the category since they entered college. A discriminant function analysis was performed for each Holland category, with measures from five factors extracted from the Omnibus Personality Inventory (28) and ACT scores as independent variables. In each category no significant difference was found in ability or personality. Thus the students' choices of major seemed independent of how they got there.

Holland's theory was also investigated by Morrow (95), who correlated scores on the VPI with scores on a questionnaire related to satisfaction with college major. Subjects were college juniors and seniors majoring in mathematics and sociology. A student's satisfaction with his major was significantly related to his personality type, as assessed by the VPI, for the mathematics but not the sociology majors. One explanation, not offered by Morrow, for the nonsignificant results in the case of sociology majors is that the mathematics sample had an 8 to 6 ratio of men to women (86 males, 61 females), while the sociology sample was over 2 to 1 (122 females, 54 males) in favor of women. As Rose & Elton (118) point out, Holland's theory may be more appropriate for men than for women.

In a related study, Southworth & Morningstar (131) used Holland's categories to explore the relationship between persistence of occupational choice and personality congruence with the choice. Personality was measured by the VPI administered to entering engineering students; persistence was determined by the status of these students at the beginning of their junior year: (*a*) those still in engineering, (*b*) those in school but not in engineering, and (*c*) those who had left the university. A multivariate discriminant function analysis showed the scores on the six scales to differentiate significantly among the three subgroups. The discriminant function weighted the artistic and social scales more than the other four.

Ansell & Hansen (3) employed in a univariate analysis of covariance to compare 8th–12th grade males on vocational maturity and socioeconomic class status. The instrument was the Readiness for Vocational Planning Scale (50). Without regard to race, there were significant differences between lower-class and middle-class students in grades 10, 11, and 12. Lower-class black and white students did not differ significantly on their scores through the five grades. No data on middle-class blacks are given.

Tseng (147) related internal-external correlated locus of control (120) with 39 variables related to rehabilitation clients' job proficiency, employability, and satisfaction with training. Nine variables correlated positively and significantly with "internal" locus of control and negatively with "externals." Variables included ability to work with others and to comply with rules. All variables that correlated significantly with internal locus of control were considered to be positive signs of employability.

In an intriguing study, Sharf (126) explored the relative importance of interest and ability in vocational decision making. Results lend further support to the hypothesis that interest is more highly related than ability to choice of vocation.

PROCESS-OUTCOME RESEARCH

In their concepts and methods, counseling psychologists have demonstrated themselves to be great borrowers from other psychological specialists. This assertion is amply supported in the area of process-outcome research; the review period 1970–71 is no exception to the rule. For example, Kelley et al (74) used the Campbell & Stanley (24) partition of research designs to evaluate process-outcome studies published in the *Journal of Counseling Psychology* for 1964–68. Three judges reading independently are reported to have agreed totally in classifying 73 out of 86 such articles. Of these, 54% were described as "pre-experimental" in design; indeed, 31% were "one-shot case studies." Of the remainder, 25% could be classified as "true experimental" and 14% as "quasi-experimental." About 8 percent were labeled as "unscientific" matching studies. The authors acknowledge an ethical problem in the random assignment of subjects to experimental treatment—or control—conditions, a design requirement that ignores the subjects' own expressed needs for help. However, Kelley et al (74) conclude that most of the published research on counseling remains, as described in 1963 (121), "open to serious question." In a similar vein, Weiss (e.g. 156) alludes to methodological errors in the application of factor analytic techniques to counseling research data, helpfully supplementing his criticism with an outline of conditions under which particular methods are to be employed.

There are pitfalls in process-outcome research into which the unwary may fall. Suppose, for example, that there is a marked shift toward the employment of "experimental" and "quasi-experimental" research design (74). Or suppose that rules for applying factor analytic methods (156) are more carefully adhered to. There remain to be answered even more fundamental questions, such as what the research was designed to accomplish in the first place, how it was conducted, whether the results as analyzed, displayed, and interpreted have anything to do with alleged intentions, and how the reported accomplishment is to be judged on epistemological as well as methodological grounds. That these are not idle concerns is attested to by Meehl (89) in a discussion of evidence that is legally admissible versus that considered by psychologists to be scientifically acceptable. The latter may offer, e.g. from laboratory experiments, generalized conclusions about conditions that affect everyday human behavior. Lawyers are more prone to accept "fireside inductions," i.e. common-sense beliefs derived from introspection and anecdote, in devising legal sanctions for human conduct. Neither route is satisfactory to Meehl, who believes that "quasi-experiments in the 'real life' setting may often be the optimal data-source."

This ideal of obtaining a close approximation between (*a*) events whose occurrence in daily life is highly probable and (*b*) their accurate reportage through psychological research was extensively discussed by Brunswik (21). The quasi-experiment (24) affords but one such approximation. As Pepinsky & Pepinsky (106) earlier demonstrated, any single method for the assessment of counseling is likely to offer both gains and opportunity costs. A schema which also derives from Brunswik's (19, 20) "conceptual focus" on events was used to indicate how, paradoxically, we may expect to attain predictive accuracy at the expense of "ecological validity." No matter how we attempt to slice the pie of counseling research, that dictum remains invariant. And so it is of interest to note that although Layton, Sandeen & Baker (81) report a "paucity . . . of experimental research on the counseling process" up to 1970, a number of such studies appeared in 1970–71. The trend seems to have been encouraged by repeated exhortation (e.g. 135): i.e. psychological experiments, constituted as "laboratory analogues" to something called "counseling," can fill the gap between "basic" research and counseling practice. The argument typifies what Meehl (89) refers to as a "methodological equation, often implicit and unquestioned . . . *Empirical = Experimental-and-quantitative = scientific* . . . objectionable on several grounds": e.g. (*a*) of epistemological inaccuracy, (*b*) of false linkage between the terms "experimental" and "quantitative," (*c*) of preempting the connotation "scientific" and thereby denigrating "non-experimental" evidence, and—as stated earlier—(*d*) of spurious generalization to [non-isomorphic] events in daily life.

Not all process-outcome research published during 1970–71 fits either the experimental or quasi-experimental paradigm. Nor is the extravagant claim of efficacy, as exemplified and legitimately criticized above (89, 135), too often voiced by those who conduct such research. For convenience in review, we have divided our exhibits into (*a*) sociopsychologically oriented research, (*b*) behavior modification, and (*c*) miscellaneous studies.

SOCIOPSYCHOLOGICALLY ORIENTED RESEARCH

More than any other clinically sophisticated psychologist, Goldstein (e.g. 45, 46, 48) has emphasized the research implications of manipulating therapeutic conditions in terms of concepts and strategies derived from experimental personality and social psychology. An excellent volume (47) has now appeared in which he reports upon a number of relevant experimental and quasi-experimental studies, the latter predominantly conducted by a research group under his direction with actual patients in therapy. A companion volume (Pepinsky & Patton 105) includes exhibits of several experiments conducted independently, whose conditions were structured so as to be isomorphic to particular circumstances of "serious life" counseling situations. Two of these, one on predicted effects of a counselor's induced "evaluative expectancy" upon his subsequent assessments of himself and his client, and the other on predicted effects of induced "attraction" and "congruence" on a client's responses toward his counselor, had been published earlier (78, 101). In the third study (150), 80 undergraduate subjects initially rated themselves on the Marlowe-Crowne (30) Social Desirability Scale (M-C SD) and were asked how they would value a psychologist's interpretation of their self-ratings. Again, following individual experimental sessions in which subjects were randomly assigned to receive either favorable or unfavorable interpretations via experimenter from a fictive psychologist, subjects again rated either themselves first and the psychologist second or the psychologist first. A 2×2×2 factorial design was used to test predictions, the first set of which—that subjects would accept and change more toward socially desirable interpretations than undesirable ones—was supported by the data. A second set of predictions, based on the assumption that higher M-C SD scoring subjects would be more defensive against interpretations than low scoring subjects, was not supported. Rather, a significant order effect and M-C SD score×interpretation interaction suggested a mode of dissonance reduction related to both individual personality (i.e. sensitivity to social demands) and situational constraints. This experiment thus incorporates into its design a quasi-correlational feature in that a pre-experimental measure of behavior was used to partition subjects into high and low M-C SD groups. Under that condition subjects were not randomly assigned to treatment groups included in the ANOVA, hence cannot be treated as independent of experimental manipulations. Although some would hold this kind of partitioning to be an indefensible basis for making tests of significance, the requirement of random assignment has also been challenged (89). Moreover, the inclusion of pre-experimental measures in the experimental design permits inferences to be drawn about individual differences among subjects (i.e. pretreatment dispositions) in relation to treatment effects (i.e. manipulated conditions) to which subjects are presumed to be assigned "at random."

A number of related experiments are reported by Schmidt & Strong (122, 123, 137, 138) along lines proposed by Strong (134). In one of these (137), 49 college student subjects rated their own achievement needs (n Ach) on a scale derived from the Edwards Personal Preference Scale (EPPS, 110); about 3 weeks before and immediately following a 20-minute interview, and again about one week after. Following the interview, each subject also rated the interviewer's "expertness" as a counselor and subject's reactions to interview and experiment. Interviewer influence upon these ratings was examined in a 2×2×2 ANOVA design, with subjects randomly assigned to conditions in which (1*a*) interviewers were introduced as expert or (1*b*) inexpert; (2*a*) interviewers acted as expert or (2*b*) inexpert; and (3*a*) one or (3*b*) another interviewer was employed. Subjects changed their ratings more under combined expert than nonexpert conditions, but between the first and third, not the first and second, ratings. As implied in other studies (e.g. Rogers, 117), counselor influence may have more evident distal than proximal effects. Also, as demonstrated elsewhere (e.g. 105), the interviewers were differentially influential in modifying client behavior. Possible order effects, i.e. of obtaining self-ratings first, followed by other dependent measures, were not determined. A feature of this study was its incorporation of normative standards of portrayed expertise derived from a previous experiment (122), in which six male counselors with widely varied experience attempted to persuade a client-confederate that he should not withdraw from the university. The first 5 minutes of each interview were videotaped and shown to 37 male undergraduates. Subjects were instructed to rate each counselor's expertness and to provide descriptions of incidents or personal attributes that had prompted the rating. Results are interpreted as showing the ratings to be almost inversely related to amount of counseling experience. A subsequent comment on these results (124), however, indicates the relationship to be nonlinear, with most of the variance attributable to the most and least experienced counselors. It is suggested instead that subjects may have based their ratings in these extreme cases on liking or disliking for the counselor, apart from his assessed expertise.

A third experiment (138) was designed to measure the effects upon counseling of client belief in the "trustworthiness" of a counselor-confederate. Two interviewers trained in the "expertness" role (122) were also trained to exhibit either trustworthy or untrustworthy behavior. In addition, subjects were led to believe that their interview would be either confidential or nonconfidential. Fifty-four male undergraduate subjects performed the customary n Ach ratings 2 weeks prior, immediately after, and about 1 week following the interview. Interviewer differences were found between the first and second ratings, yet did not persist over time. A confidentiality effect differentiated between the second and third ratings. The trustworthy manipulation was nondifferentiating, however, a possible consequence (as the authors point out) of weak role induction. In a fourth experience (123), 54 male undergraduates were randomly assigned to one of two "psychologists" under high or low "attractiveness" conditions. Dependent measures were the familiar n Ach ratings, an adjective check list on which to react to interviewer attractiveness (after the interview), and a direct question as to whether the interviewer had influenced their ratings (about 1 week later) after debriefing. For 41 subjects, each assigned to one of the four experimental conditions, the interviewer again tried to influence their n Ach ratings; for 13 "control" subjects, similarly assigned, there was no such attempt. "Control" subjects changed their ratings significantly less than the "experimental" groups. For the latter, there was a significant "attractiveness"×interviewer interaction; the intended manipulation alone had no such effect. Again, it is possible that the manipulation itself, though perceived as intended, was weak. As an interesting sidelight, 11 out of 21 subjects exposed to the "attractive" interviewer stated, after debriefing, that he had not tried to influence their ratings, while only 4 out of 20 who saw the "unattractive" interviewer thought that he had not done so.

A companion pair of experiments (136) tested (*a*) an "additive" and (*b*) a "masking" hypothesis about the combined effects of "expertness" and "attractiveness" upon client behavior. Apparently hypothesis (*a*) wins more support than hypothesis (*b*) in that there is an immediate differential for attractiveness under "expert" but not "nonexpert" conditions. About 1 week after "counseling," however, differential "attractiveness" effects are found under both conditions. An unfortunate feature of this last report is that in its increased complexity of design and execution it becomes very difficult to follow and interpret. Editing of language would also have helped; e.g. we are told about "subjects receiving the unattractive role" or "unattractive role subjects."

Convolution of design and reportage is also evident in still another experiment by Strong et al (139). Here two highly experienced male counselors conducted 10-minute simulated counseling interviews with a male confederate, in both of which the counselors were audio and videotaped. In one of the interviews, the counselor either moved and gestured a great deal or remained as still as possible. Subjects were 86 female undergraduates. On an adjective check list the counselors seem to have been identified more negatively when seen and heard than when heard only. Frequent movement was more positively responded to than stillness, which was typified as cold, aloof, and analytic. Again, counselors had differential effects upon their audience. At one point the authors comment wryly that it might be better if counselors were heard but not seen by students. At another, the sole use of "audio recordings" in counselor supervision is inveighed against. At still another, we read that "interpersonal attractiveness or likableness (sic) form a bipolar dimension in interpersonal space." Apparently this means that to give the impression of being logical and powerful one must also seem aloof and cold; or to be seen as warm and friendly is also to be seen as "muddle-headed." But it is a giant step from such a setting in which female college students merely viewed and/or heard (presumably white, "middle class") male counselor-and-client-confederates in a brief role-playing situation, to counseling and its outcomes outside of the laboratory. Yet the authors unhesitatingly bridge this gap, without explicit attention to common formal properties that might conceivably link the two sets of events (cf 105). Meehl's caveat against overgeneralizing (89) applies here.

A more cautious view of things is taken by Kaul & Schmidt (73) in further investigation of trustworthiness. Five male upper division students served as interviewers in the videotaping of interviewer behavior in 24 brief scenes representing early, middle, and late counseling interview segments. These were enacted from basic scripts depicting both trustworthy and untrustworthy content and manner to a criterion of unanimous agreement by judges. Undergraduate and graduate student subjects (n=16 for each sample, composed equally of males and females) were asked to rate the interviewers' trustworthiness. A sophisticated but readily comprehensible ANOVA design and analysis revealed half of the subjects, given an advance definition of the term, to make higher ratings than those not given the definition. Although undergraduates viewed the interviewers as more trustworthy than graduates, there were no sex differences. Among other findings, ratings tended to decrease from "initial" to "final" segments of the interview, and initial differences between interviewer content and manner are markedly diminished for the last two segments. However, a significant, admittedly complex interaction among the five main effects partitioned for analysis is not discussed. As the authors imply and demonstrate, clinical study of a phenomenon may be enriched when its effects can be thus experimentally tested in the laboratory. Viewed in this light, a quasi-correlational pilot experiment (72) has provocative implications for systematic research into placebo effects on counseling outcomes.

It is interesting to note in the above experiments (123, 136, 137, 139) that although subjects could be induced to believe in the greater or lesser "attractiveness" of an interviewer-confederate, anticipated effects of this variable upon subjects' subsequent behavior were either not obtained (123) or are subject to equivocal interpretation (136). Using hypotheses relevant to balance theory and a relevant manipulation of interviewer attractiveness (cf Newcomb 99), however, Patton (101) found predicted effects. Again, though differential treatment effects were found for subjects induced to believe in the interviewer's greater or lesser "expertness" (123, 136, 139), Sprafkin (132) found no such effect. Also using hypotheses related to balance theory, Sprafkin (132) designed an experiment to test whether subjects could be induced to modify word-referent relationships according to interviewer expertise. Two male counselor-confederates either advocated changes in word meanings or did not advocate such changes during interviews with 64 male undergraduate subjects, given opportunity to practice the role of a client. The interviewers were both introduced and acted as either highly expert or low in expertise as counselors. Dependent measures included changes from before to after counseling in subjects' ratings of the relative appropriateness in word-synonym pairs, and subjects' rated confidence in these ratings. An additional set of items to be rated included amount of interviewer expertise. Predicted rating changes were not obtained. Despite subjects' clear identification of interviewer expertise, as intended, the only significant effect upon both appropriateness and confidence ratings was the interviewer's advocacy or nonadvocacy of change. Counselors did not differentiate subjects' ratings, nor did interactions, including the predicted expertise × advocacy of change effect.

Failure to replicate findings from the one set of experiments to the other is understandable. Conceptual, terminological, and methodological disparities are apparent, though what is related to what and why is rarely as explicit in this kind of research as some have claimed. Nor is there an evident isomorphism between phenomena thus isolated and those far more ambiguously identified for us as "actual counseling." The virtue of the sociopsychologically articulated and "counseling" relevant experiment, as compared with many other kinds of inquiry, is that its sins of omission and commission are often more glaringly obviously and therefore more readily diagnosed and remedied. We shall have more to say about all this in concluding our review.

COUNSELING AS BEHAVIOR MODIFICATION

Two years ago there appeared in the *Annual Review of Psychology* adjacent chapters on counseling (81) and behavior therapy (76). Both reviews allude briefly to a recently emerging hybrid called "behavioral counseling." Persons who thus label the focus of their published research have tended to be concerned with students in educational settings. However, recourse to a common technology of behavior and modification in this and other labeled varieties of psychological treatment (cf 105) has further confused attempts to distinguish among them. Apart from reported case studies of situations "involving unusual techniques," it seems, there were few earlier published accounts of research on "counseling" as behavior modification (76). Within the review period 1970–71, a number of more elaborate studies appeared. Most of these report on the effects of exposing students to reinforcement or "modeling" techniques. Several studies in this group are noteworthy for their employment of (*a*) settings that have "ecological validity" for research subjects and (*b*) experimenters who manipulate conditions by means of techniques that are used to define counseling itself as behavior modification. In the latter sense, experimenters are a current portrayal of an idealized practitioner-and-scientist type (106). In the former, the research has attributes that approximate an idealized quasi-experimental design (24).

Persons familiar with research on behavior modification will recognize a prototypic form of experiment in a relatively well-designed study by Tosi et al (141). "Reticent" 6th and 7th-grade pupils ($n = 24$), recommended for counseling by their teachers, were randomly assigned to one of four treatments: (1*a*) operant social reinforcement; (1*b*) a modified reinforcement, after Premack (111); (1*c*) a teacher expectation; and (1*d*) a control condition ($n = 6$ in each). Three graduate students serving as counselors (2) were randomly assigned within treatment conditions, such that each counselor worked with two students under each condition. Treatment periods of 30 minutes each were conducted once a week for (we infer) a total of six sessions. Under the two nonreinforcement conditions, students were taken to see a movie and questioned about it afterward. Under condition (1*c*), in addition, teachers were informed of each child's "remarkable progress" and were led to expect increased verbal output from him. All students were informed that this was the purpose of their "counseling." Pretreatment criterion measures were obtained for each subject by an observer in his classroom for 1 hour/day over a 3-day period, and consisted of a tally made each time a subject raised his hand or spoke. Posttreatment measures were similarly obtained one week after the last treatment. Significant main effects on these measures are registered for treatments and counselors. The treatments-counselor interaction was not significant. Gains were significantly greater for the social reinforcement group than for the expectancy and control groups. When subjects served as their own control, significant absolute gains were evident for the two reinforcement conditions. One of the three counselors, a female, accounted for significantly higher scores for subjects across all four treatment conditions than the other two (male) counselors. The authors comment that "Some counselors, above and beyond technique, appear to be more potent reinforcers (sic) than others under a variety of conditions."

An indication of why this might be is given in a quasi-correlational study of "facilitative" and "non-facilitative" counselors (92). Graduate students without previous counseling experience were identified as "high" (4 males, 4 females) and "low facilitative" (3 males, 5 females) on a pretest adapted from previous research (144). After training in "verbal reinforcement techniques," each counselor was randomly assigned three clients from a pool of 48 11th-grade students (24 female and 24 male) from 12 high schools. In a single counseling interview with each client, the counselor acted to supply pertinent cues for and positive reinforcements of information-seeking behavior. Criterion measures included amount of (*a*) information-seeking and (*b*) noninformation-seeking behavior within the interview, and (*c*) length of interviews. An ANOVA of main effects revealed high facilitators to elicit a significantly greater amount of information seeking than low-scoring ones. Male clients engaged in more noninformation seeking than females, however, and there is an unexplained complex interaction between sex of client and counselor effects on that measure. No such effects were found on length of interview. "Behavioral techniques" alone, these authors remind us, may not be sufficient to account for observable changes in the client.

Bednar et al (9) further illustrate how counseling to alleviate a presumed learning deficit may be used to provide "competence training." Again, the knowledgeable student of behavior modification will recognize a prototypic strategy of operant conditioning with "selected target" groups. In a rehabilitation school for delinquent boys, 32 subjects were given one-hour weekly reading lessons, based on the SRA programmed reading kit, over an 18-week period. Subjects were randomly assigned to reinforcement or nonreinforcement conditions. Under the latter, subjects received an "ice cream feed" every 5–7 days; while under the former, subjects received monetary reinforcement for both initial "attention, cooperation, and persistence" (phased out after lesson 6) and for "actual reading competency." Two undergraduate experimenters (male and female) proctored the lessons, answered questions, corrected answer sheets, and provided reinforcements. Whether the same experimenters monitored the nonreinforcement condition and how it was monitored are not stated. Dependent measures were (*a*) an accompanying SRA weekly reading achievement test, (*b*) the Gates-MacGinitie Reading Test for content not included in the instructional kit, (*c*) the San Diego Inventory of Reading Attitudes, and (*d*) classroom teachers' ratings of student conduct. The authors state that because subjects' reading instruction was provided in their own living quarters, these teachers, in a local public school to which subjects were bussed daily, were unaware of the special reading program for some students. A second variable, explicitly provided for in the design, was pre-posttreatment gains on these measures. Use of a repeated measures ANOVA design reveals significant pre-posttest differences in reading comprehension score gains between groups receiving and not receiving operant conditioning. There is also a significant interaction between treatments and gains on the more general reading measure, and the two groups—said to be initially undifferentiated—received significantly disparate posttreatment teacher ratings of conduct in the classroom. Only the reading attitude measure, for unexplained reasons, was nondifferentiating. How lasting these differentiating effects are is not made evident; the authors neglect to mention when the before and after measures were given. Nor is there warrant for their final admonitions (*a*) "that teachers aware of conditioning principles . . . are in a good position to understand and manipulate the dynamics that may influence successful teaching," or (*b*) that counseling psychologists ought to be serving as consultants toward this end.

The foregoing studies have been reported in some detail to give an idea of a genre that is rapidly being assimilated into the literature of counseling psychology. Until a new fad appears to replace current enthusiasm for social engineering of this kind, we are apt to see an increasing number of such adaptations from a still burgeoning volume of publications on behavior modification. During the review period, for example, "behavioral counseling" research was reported on students identified as alienated (153, 154), anxious (49), and unassertive (60), phobic to snakes (38), in rural schools (91), more and less self-actualizing (61), and superior (6). These studies vary in treatment technique employed, rationale, design, execution, and overall quality. One of the more interesting of these is a quasi-correlational experiment (60) in which a repeated measures design was used to test the effects of "behavioral rehearsal" and "modeling" effects over 6 weeks of training followed by posttests 6 and 7 weeks after termination of treatments. Initial differences, clearly favoring the two experimental groups over control subjects, had dissipated markedly by the end of the follow-up period. There is a trend in these studies for reinforcement and modeling to produce desired kinds of changes, with perhaps a slight edge for modeling. As noted, however, such effects may not be durable ones, and there is need for further research on personal dispositions that may allow some behavioral technologists to be more proficient than others. In view of an earlier reluctance on the part of some counseling psychologists to accept the idea that clients could be counseled in groups, the efficacy of group procedures of this kind—repeatedly demonstrated in these exhibits—should also be noted. Another intriguing experiment by Frankel (40), where female undergraduates counseled each other in a "microcounseling" situation under "videotape modeling" and videotaped feedback conditions, is flawed by an overly complex design and a plethora of dependent measures. Prior determination of relationships among the latter would have helped in the analysis and interpretation of results. Two or three less inclusive experiments in lieu of the all-in-one design would also have been more easily interpreted, along with statistical tests for score gains by means of a repeated measures design. The author's test for order effects in the sequence of treatment conditions yielded significantly different results, however, and is to be applauded.

MISCELLANEOUS

Brief mention can be made of several additional studies, which for want of numerical representation in other categories have been lumped together here. In one of these (52), male and female subjects used semantic differential (SD) ratings to report their reactions to two persons seated at varying distances from each other; ratings were to be made as if a subject were in the situation as a client with a personal or academic problem. SD ratings were affected by distance but not "instructional set." A study of interviewee self-disclosure (66) is notable mainly because of the devastating criticism it elicited (12), followed by a response (67) whose "self-disclosures" lead one to question why either the initial study (66) or the rebuttal (67) ever should have been published. Two "group marathon" studies (51, 159) are noteworthy only because they center on one of the newer, more "far out" therapeutic techniques about which counselors as yet seem to have been less enthusiastic than clinical psychologists. A study which purports to study "therapist-led" and "leaderless" group psychotherapy effects upon rated patient behavior (133) seems to have been elaborately concertized for the sparse yield of results (also difficult to decipher) that it offers. In like vein, though one must admire the psychometric technology involved in a correlational analysis of two "interest" inventories and a "personality" measure (98), one is hard put to understand the "implications for practical utilization in counseling" claimed by the authors. Finally, the usual individual differences in counselor effects are reported (33); highly "empathic" counselors are asserted to be more "successful" than those low in empathy, with more experienced counselors higher in empathy than inexperienced ones (96); differential rehabilitation counseling effects are shown for differentially diagnosed clients (112); a mistitled study yields ambiguous results (59); and there are the vanishing "preexperimental" studies (e.g. 64, 113) which purport to tell us what happened to samples of clients already treated.

CONCLUSIONS

In one sense, counseling research has not had to undergo a metamorphosis comparable to that in many other branches of scientific and technical inquiry. From its inception, such research has been relevant to problems encountered in settings where counseling occurs. More often than not, the research has been conducted in situ, with subjects assessed for their performance of "serious life" tasks. At the same time, there has been increasing alignment of investigative concerns with the theoretical and technical products of basic research work in other areas of psychology, notably in human learning and development, and personality-social psychology. Sophistication in matters of psychometric and statistical analysis, long conspicuous in publications by counseling psychologists, also seems to have been enhanced. Save in those relatively few cases where the symbiotic attachment of practitioner and scientist (104) may have produced a blatant "hard sell" (e.g. 143, 144), there is an evidently growing concern for precision of inquiry. However, the incorporation of precision technologies—as in behavior modification, simulation, and the laboratory experiment—brings other problems to the fore, e.g. of research ethics (75–77, 103, 148) and the imminence of rebellion by at least some subjects and clients. The latter becomes increasingly possible with the greater likelihood today of conflict arising from cross-cultural misunderstanding between persons who give and receive psychological treatment. In that arena, many a belief in the efficacy of research as well as counseling is already being sorely tested. Reeducation of practitioners and scientists along these lines is indicated (105).

LITERATURE CITED

1. Anderson, W. 1970. Service offered by college counseling centers. *J. Couns. Psychol.* 17:380–82
2. Andrews, W. R. 1971. Behavioral and client-centered counseling of high school underachievers. *J. Couns. Psychol.* 18:93–96
3. Ansell, E. M., Hansen, J. C. 1971. Patterns in vocational development of urban youth. *J. Couns. Psychol.* 18:505–8
4. Arbuckle, D. S. 1971. Educating who for what? *Couns. Educ. Superv.* 11: 41–48
5. Astin, H. S., Suniewick, N., Dweck, S. 1971. *Women, A Bibliography on Their Education and Careers.* Washington, D.C.: Hum. Serv. Press
6. Atkinson, D. R. 1971. Effect of selected behavior modification techniques on student-initiated action. *J. Couns. Psychol.* 18:395–400
7. Bartlett, W. E., Thompson, C. E. 1971. Counselor preparation: a semantic differential evaluation. *Couns. Educ. Superv.* 11:129–36
8. Bednar, R. L., Weinberg, S. 1970. Ingredients of successful treatment programs for underachievers. *J. Couns. Psychol.* 17:1–7
9. Bednar, R. L., Zelhart, P. F., Greathouse, L., Weinberg, S. 1970. Operant conditioning principles in the treatment of learning and behavior problems with delinquent boys. *J. Couns. Psychol.* 17:492–97
10. Beyer, H. N. 1971. Effect of students' knowledge of their predicted grade point average on academic achievement. *J. Couns. Psychol.* 18:603–5
11. Bishop, J. B. 1971. Another look at counselor, client and supervisor ratings of counselor effectiveness. *Couns. Educ. Superv.* 10:319–24
12. Bloch, E. L., Goodstein, L. D. 1971. Comment on "Influence of an interviewer's disclosure on the self-disclosing behavior of interviewees." *J. Couns. Psychol.* 18:595–97
13. Bodden, J. L. 1970. Cognitive complexity as a factor in appropriate vocational choice. *J. Couns. Psychol.* 17:364–68
14. Bordin, E. S. 1946. Diagnosis in counseling and psychotherapy. *Educ. Psychol. Meas.* 6:169–84
15. Bordin, E. S. 1970. Review of C. B. Truax & R. R. Carkhuff. Toward effective counseling and psychotherapy. *Commun. Ment. Health J.* 6:78–80
16. Bordin, E. S., Shaevitz, M. H., Lacher, M. 1970. Entering college students' preparation for self-regulation. *J. Couns. Psychol.* 17: 291–98
17. Brown, R. D. 1970. Experienced and inexperienced counselors' first impressions of clients and case outcomes: are first impressions lasting? *J. Couns. Psychol.* 17:550–58
18. Brown, W., Holtzman, W. 1956. *Survey of Study Habits and Attitudes.* New York: Psychological Corp.
19. Brunswik, E. 1939. The conceptual focus of some psychological systems. *J. Unified Sci.* 8:36–49
20. Brunswik, E. 1943. Organismic achievement and environmental probability. *Psychol. Rev.* 50:255–72
21. Brunswik, E. 1956. *Perception and the Representative Design of Psychological Experiments.* Berkeley: Univ. California Press
22. Byrne, R. H. 1958. Proposed revision of the Bordin-Pepinsky diagnostic constructs. *J. Couns. Psychol.* 5: 184–87
23. Callis, R. 1965. Diagnostic classification as a research tool. *J. Couns. Psychol.* 12:238–43
24. Campbell, D., Stanley, J. 1966. *Experimental and Quasi-experimental Designs for Research.* Chicago: Rand-McNally
25. Campbell, R. J., Kagan, N., Krathwohl, D. R. 1971. The development and validation of a scale to measure affective sensitivity (empathy). *J. Couns. Psychol.* 18:407–12
26. Carkhuff, R. R. 1969. *Helping and Human Relations: A Process for Lay and Professional Helpers, Volume I. Selection and Training.* New York: Holt, Rinehart & Winston
27. Carkhuff, R. R., Bierman, R. 1970. Training as a preferred mode of treatment of parents of emotionally disturbed children. *J. Couns. Psychol.* 17:159–61
28. Center for the study of higher education 1962. *Omnibus Personality Inventory Research Manual.* Berkeley, California

29. Cooperative Test Division 1955. *Cooperative School and College Ability Tests, Examiner's Manual.* Princeton: Educational Test. Serv.
30. Crowne, D. P., Marlowe, D. 1964. *The Approval Motive.* New York: Wiley
31. Duguid, J. G. 1968. *Trends in types of problems presented to the University of Wyoming Division of Counseling and Testing, 1960–1967.* Unpublished masters thesis. Univ. Wyoming
32. Eberlein, L., Park, J. 1971. Self-concept/ideal self-concept congruence and rated effectiveness of counselor trainees. *Couns. Educ. Superv.* 10:126–31
33. Edwards, B. C., Edgerly, J. W. 1970. Effects of counselor-client cognitive congruence on counseling outcome in brief counseling. *J. Couns. Psychol.* 17:313–18
34. Eisenberg, S., Delaney, D. J. 1970. Using video simulation of counseling for training counselors. *J. Couns. Psychol.* 17:15–19
35. Elton, C. F., Rose, H. A. 1971. A longitudinal study of the vocationally undecided male student. *J. Vocat. Behav.* 1:85–92
36. Engelkes, J. R., Roberts, R. R. 1970. Rehabilitation counselor's level of training and job performance. *J. Couns. Psychol.* 17:522–26
37. English, R. W., Jelenevsky, S. 1971. Counseling behavior as judged under audio, visual, and audiovisual communication conditions. *J. Couns. Psychol.* 18:509–13
38. Fishman, S. T., Newas, M. M. 1971. Standardized desensitization method in group treatments. *J. Couns. Psychol.* 18:520–23
39. Fitts, W. H. 1965. *Manual, Tennessee Self-Concept Scale.* Nashville, Tenn.: Counselor Recording & Tests
40. Frankel, M. 1971. Effects of videotape modeling and self-confrontation techniques on microcounseling behavior. *J. Couns. Psychol.* 18:465–71
41. Freeman, H. R., Brubaker, P. 1971. Personality characteristics of campus demonstrators compared to nondemonstrators. *J. Couns. Psychol.* 18:462–64
42. Garfield, S. L., Bergin, A. E. 1971. Therapeutic conditions and outcome. *J. Abnorm. Psychol.* 77:108–14
43. Gelso, C. J. 1970. Two different worlds: a paradox in counseling and psychotherapy. *J. Couns. Psychol.* 17:271–78
44. Gilbreath, S. 1971. Comparison of responsive and nonresponsive underachievers to counseling service aid. *J. Couns. Psychol.* 18:81–84
45. Goldstein, A. P. 1962. *Therapist-Patient Expectancies in Psychotherapy.* New York: Macmillan
46. Goldstein, A. P. 1966. Psychotherapy research by extrapolation from social psychology. *J. Couns. Psychol.* 13:38–45
47. Goldstein, A. P. 1971. *Psychotherapeutic Attraction.* Elmsford, N.Y.: Pergamon
48. Goldstein, A. P., Heller, K., Sechrest, L. 1966. *Psychotherapy and the Psychology of Behavior Change.* New York: Wiley
49. Graff, R. W., MacLean, G. D., Loving, A. 1971. Group reactive inhibition and reciprocal inhibitions therapies with anxious college students. *J. Couns. Psychol.* 18:431–36
50. Gribbons, W. D., Lohner, P. R. 1968. *Emerging Careers.* New York: Teachers College, Columbia Univ. Bur. Publ.
51. Guinan, J. F., Foulds, M. L. 1970. Marathon group: facilitator of personal growth? *J. Couns. Psychol.* 17:145–49
52. Haase, R. F. 1970. The relationship of sex and instructional set to the regulation of interpersonal interaction distance in a counseling analogue. *J. Couns. Psychol.* 17:233–36
53. Hager, P. C., Elton, C. F. 1971. The vocational interests of black males. *J. Vocat. Behav.* 1:153–58
54. Hall, L. G. 1968. *Counselor's Manual—Hall Occupational Orientation Inventory.* Chicago: Fallett
55. Hansen, J. C., Warner, R. W. 1971. Review of research on practicum supervision. *Couns. Educ. Superv.* 10:261–72
56. Harman, R. S. 1971. Client assessment of a university counseling service. *J. Couns. Psychol.* 18:496–97
57. Harmon, L. W. 1970. Anatomy of career commitment in women. *J. Couns. Psychol.* 17:77–80
58. Harmon, L. W. 1971. The childhood and adolescent career plans of

college women. *J. Vocat. Behav.* 1:45–46

59. Healey, C. C. 1971. Reducing error variance attributable to social desirability. *J. Couns. Psychol.* 18: 132–37
60. Hedquist, F. J., Weinhold, B. K. 1970. Behavioral group counseling with socially anxious and unassertive college students. *J. Couns. Psychol.* 17:237–42
61. Hekmat, H., Theiss, M. 1971. Self-actualization and modification of affective self-disclosures during a social conditioning interview. *J. Couns. Psychol.* 18:101–5
62. Holland, J. L. 1966. *The Psychology of Vocational Choice.* Waltham, Mass.: Blaisdell
63. Holland, J. L. 1971. A theory ridden computerless vocational guidance system. *J. Vocat. Behav.* 1:167–76
64. Horton, M., Kriauciunas, R. 1970. Minnesota Multiphasic Personality Inventory differences between terminators and continuers in youth counseling. *J. Couns. Psychol.* 17:98–101
65. Houston, B. K. 1971. Sources, effects, and individual vulnerability of psychological problems for college students. *J. Couns. Psychol.* 18: 157–65
66. Jourard, S. M., Jaffe, P. E. 1970. Influence of an interviewer's disclosure on the self-disclosing behavior of interviewees. *J. Couns. Psychol.* 17:252–57
67. Ibid 1971. Comments on Bloch and Goodstein's comments on our paper, "Influence of an interviewer's disclosure on the self-disclosing behavior of interviewees." 18: 598–600
68. Kagan, N. et al 1967. Studies in human interaction: interpersonal process recall stimulated by videotape. *Final Rep. RR-20 U. S. Dep. HEW.* East Lansing, Mich.: Michigan State Univ. Educ. Publ. Serv.
69. Kagan, N., Schauble, P. G. 1969. Affect simulation in interpersonal process recall. *J. Couns. Psychol.* 16:309–13
70. Kagan, N., Schauble, P. G., Resnikoff, A., Danish, S. J., Krathwohl, D. R. 1969. Interpersonal process recall. *J. Nerv. Ment. Dis.* 148: 365–74
71. Katkin, S., Ginsburg, M., Rifkin, M. J., Scott, J. T. 1971. Effectiveness of female volunteers in the treatment of outpatients. *J. Couns. Psychol.* 18:97–100
72. Kaul, T. J., Parker, C. A. 1971. Suggestibility and expectancy in a counseling analogue. *J. Couns. Psychol.* 18:536–41
73. Kaul, T. J., Schmidt, L. D. 1971. Dimensions of interviewer trustworthiness. *J. Couns. Psychol.* 18: 542–48
74. Kelley, J., Smits, S. J., Leventhal, R., Rhodes, R. 1970. Critique of the designs of process and outcome research. *J. Couns. Psychol.* 17: 337–41
75. Kelman, H. C. 1968. *A Time to Speak: On Human Values and Social Research.* San Francisco: Jossey-Bass
76. Krasner, L. 1971. Behavior therapy. *Ann. Rev. Psychol.* 22:483–532
77. Krasner, L. 1969. Behavior modification—values and training. In *Behavior Therapy: Appraisal and Status*, ed. C. M. Franks, 537–66. New York: McGraw-Hill
78. Kumar, U., Pepinsky, H. B. 1967. A counselor's evaluative expectancy and his interpersonal response to a client. *J. Couns. Psychol.* 14:41–50
79. Kuvlesky, W. P., Patella, V. M. 1971. Degree of ethnicity and aspirations for upward social mobility among Mexican American youth. *J. Vocat. Behav.* 1:231–44
80. Kuvlesky, W. P., Wright, D. E., Juarez, R. Z. 1971. Status projections and ethnicity: a comparison of Mexican American, Negro and Anglo youth. *J. Vocat. Behav.* 1: 137–51
81. Layton, W. L., Sandeen, C. A., Baker, R. D. 1971. *Ann. Rev. Psychol.* 22:533–64
82. Levitt, E. S. 1971. Vocational development of professional women. *J. Vocat. Behav.* 1:375–85
83. Lin, Y-G., McKeachie, W. J. 1970. Aptitude, anxiety, study habits, and academic achievement. *J. Couns. Psychol.* 17:306–9
84. Linden, J. D., Stone, S. C., Shertzer, B. 1965. Development and evaluation of an inventory for rating counseling. *Personnel Guid. J.* 44: 267–76
85. Long, T. E., Impellitteri, J. T. 1971. Ethical practice: preserving human dignity. *Personnel Guid. J.* 50: 246–340
86. Lowe, C. M. 1969. *Value Orientation in Counseling and Psychotherapy:*

The Meaning of Mental Health. San Francisco: Chandler

87. Mazer, G. E., Engle, K. B. 1971. Personality and attitude change in counselor trainees: an evaluation. *Couns. Educ. Superv.* 10:273–81
88. McArthur, C. C. 1970. Comment on effectiveness of counselors and counselor aides. *J. Couns. Psychol.* 17:335–36
89. Meehl, P. E. 1971. Law and the fireside inductions: some reflections of a clinical psychologist. *J. Soc. Issues* 27(9):65–100
90. Merchenbaum, D. H., Smart, S. 1971. Use of direct expectancy to modify academic performance and attitudes of college students. *J. Couns. Psychol.* 18:531–35
91. Meyer, J. B., Strowig, W., Hosford, R. E. 1970. Behavioral-reinforcement counseling with rural high school youth. *J. Couns. Psychol.* 17:127–32
92. Mickelson, D. J., Stevic, R. R. 1971. Differential effects of facilitative and nonfacilitative behavioral counselors. *J. Couns. Psychol.* 18: 314–19
93. Milliken, R. L., Kirchner, R. Jr. 1971. Counselor's understanding of student's communication as a function of the counselor's perceptual defense. *J. Couns. Psychol.* 18: 14–18
94. Monke, R. H. 1971. Effect of desensitization on the training of counselors. *J. Couns. Psychol.* 18:320–23
95. Morrow, J. M. Jr. 1971. A test of Holland's theory of vocational choice. *J. Couns. Psychol.* 18: 422–25
96. Mullen, J., Abeles, N. 1971. Relationship of liking, empathy, and therapist's experience to outcome of therapy. *J. Couns. Psychol.* 18: 39–43
97. Myrick, R. D., Pare, D. D. 1971. A study of the effects of group sensitivity training with student counselor-consultants. *Couns. Educ. Superv.* 11:90–96
98. Navran, L., Kendall, L. M. 1971. A canonical correlation analysis of the Strong Vocational Interest Blank, the Holland Vocational Preference Inventory and the Edwards Personal Preference Schedule. *J. Couns. Psychol.* 18: 514–19
99. Newcomb, T. M. 1968. Interpersonal balance. In *Cognitive Consistency: A Source Book*, ed. R. P. Abelson et al, 28–51. Chicago: Rand McNally
100. Pallone, N. J., Rickard, F. S., Hurley, R. B. 1970. Key influences of occupational preference among black youth. *J. Couns. Psychol.* 17:498–501
101. Patton, M. J. 1969. Attraction, discrepancy, and psychological treatment. *J. Couns. Psychol.* 16:317–24
102. Pepinsky, H. B. 1948. The selection and use of diagnostic catagories in clinical counseling. *Appl. Psychol. Monogr.* 15
103. Pepinsky, H. B. 1966. Help-giving in search of a criterion. In *Guidance in American Education*, ed. E. Landy, A. M. Kroll, 3:197–223. Cambridge: Harvard Univ. Press
104. Pepinsky, H. B. 1970. Psychological help-giving as informed definition of the situation. In *People and Information*, ed. H. B. Pepinsky, 261–95. Elmsford, N. Y.: Pergamon
105. Pepinsky, H.B., Patton, M. J., Eds. 1971. *The Psychological Experiment: A Practical Accomplishment.* Elmsford, N. Y.: Pergamon
106. Pepinsky, H. B., Pepinsky, P. N. 1954. *Counseling: Theory and Practice.* New York: Ronald
107. Pierce, R. M., Schauble, P. G. 1970. Graduate training of facilitative counselors: The effects of individual supervision. *J. Couns. Psychol.* 17:210–15
108. Ibid 1971. Follow-up study on the effects of individual supervision in graduate school training. 18:186–87
109. Pierce, R. M., Schauble, P. G. 1971. Toward the development of facilitative counselors: The effects of practicum instruction and individual supervision. *Couns. Educ. Superv.* 11:83–89
110. Poland, W. D. 1963. *An exploration of the relationship between self-estimated and measured personality characteristics in the open and closed mind.* PhD thesis. Ohio State Univ., Columbus
111. Premack, D. 1965. Reinforcement theory. *Nebr. Symp. Motiv.* 13: 123–28
112. Reagles, K. W., Wright, G. R. Butler, A. J. 1971. Rehabilitation gain: relationship with client char-

acteristics and counselor intervention. *J. Couns. Psychol.* 18:490–95

113. Redding, R. 1971. Self-referred students and other-referred students using college counseling services. *J. Couns. Psychol.* 18:22–25
114. Resnick, H., Gelso, C. J. 1971. Differential perceptions of counseling role: a reexamination. *J. Couns. Psychol.* 18:549–53
115. Resnikoff, A., Kagan, N., Schauble, P. G. 1970. Acceleration of psychotherapy through simulated videotape recall. *Am. J. Psychother.* 24:102–11
116. Robinson, F. P. 1963. Modern approaches to counseling diagnosis. *J. Couns. Psychol.* 10:325–33
117. Rogers, C. R. 1952. The case of Mrs. Oak. In *Studies in Client-Centered Therapy*, ed. T. Gordon, D. L. Grummon, C. R. Rogers, J. Seeman, 47–163. Washington, D.C.: Psychol. Serv. Center Press
118. Rose, H. A., Elton, C. F. 1971. Sex and occupational choice. *J. Couns. Psychol.* 18:456–61
119. Rossmann, J. E., Kirk, B. A. 1970. Factors related to persistence and withdrawal among university students. *J. Couns. Psychol.* 17:56–62
120. Rotter, J. B. 1966. Generalized expectancies for internal versus external control of reinforcement. *Psychol. Monogr.* 80:1 (Whole No. 609)
121. Schmidt, L. D., Pepinsky, H. B. 1965. Counseling research in 1963. *J. Couns. Psychol.* 12:418–28
122. Schmidt, L. D., Strong, S. R. 1970. "Expert" and "inexpert" counselors. *J. Couns. Psychol.* 17:115–18
123. Ibid 1971. Attractiveness and influence in counseling. 18:348–51
124. Schwartz, J. 1971. Comment on " 'Expert' and 'inexpert' counselors." *J. Couns. Psychol.* 18:180–81
125. Shappell, D. L., Hall, L. G., Tarrier, R. B. 1971. Perceptions of the world of work: inner city vs. suburbia. *J. Couns. Psychol.* 18:55–59
126. Sharf, R. 1970. Relative importance of interest and ability in vocational decision making. *J. Couns. Psychol.* 17:258–62
127. Sharp, W. H., Marra, H. A. 1971. Factors related to classification of client problem, number of counseling sessions, and trends of client problems. *J. Couns. Psychol.* 18:117–22
128. Shostrom, E. L. 1966. *Manual for the Personal Orientation Inventory.* San Diego: Educ. Ind. Test. Serv.
129. Sieka, F., Taylor, D., Thompson, B., Muthard, J. 1971. A critique of the effectiveness of counselors and counselor aides. *J. Couns. Psychol.* 18:362–64
130. Smith, P. M. 1971. Black activists for liberation, not guidance. *Personnel Guid. J.* 49:721–26
131. Southworth, J. A., Morningstar, M. E. 1970. Persistance of occupational choice and personality congruence. *J. Couns. Psychol.* 17:409–12
132. Sprafkin, R. P. 1970. Communicator expertness and changes in word meanings in psychological treatment. *J. Couns. Psychol.* 17:191–96
133. Sterne, D. M., Seligman, M. 1971. Further comparisons of verbal behavior in therapist-led, leaderless, and alternating group psychotherapy sessions. *J. Couns. Psychol.* 18:472–77
134. Strong, S. R. 1968. Counseling: an interpersonal influence process. *J. Couns. Psychol.* 15:215–24
135. Ibid 1971. Experimental laboratory research in counseling. 18:106–10
136. Strong, S. R., Dixon, D. N. 1971. Expertness, attractiveness, and influence in counseling. *J. Couns. Psychol.* 18:562–70
137. Strong, S. R., Schmidt, L. D. 1970. Expertness and influence in counseling. *J. Couns. Psychol.* 17:81–87
138. Ibid. Trustworthiness and influence in counseling, 197–204
139. Strong, S. R., Taylor, R. G., Bratton, J. C., Loper, R. G. 1971. Nonverbal behavior and perceived counselor characteristics. *J. Couns. Psychol.* 18:554–61
140. Theodorson, G. A., Theodorson, A. G. 1969. *A Modern Dictionary of Sociology.* New York: Crowell
141. Tosi, D. J., Upshaw, K., Lande, A., Walron, M. A. 1971. Group counseling with nonverbalizing elementary students: differential effects of Premack and social reinforcement techniques. *J. Couns. Psychol.* 18:437–40
142. Truax, C. B. 1961. The process of group psychotherapy: relationships between hypothesized therapeutic conditions and interpersonal exploration. *Psychol. Monogr.* 75:7 (Whole No. 511)

143. Truax, C. B. 1971. Effectiveness of counselor and counselor aides: a rejoinder. *J. Couns. Psychol.* 18: 365–66
144. Truax, C. B. et al 1966. Therapist empathy, genuineness, and warmth and patient therapeutic outcome. *J. Consult. Psychol.* 30:395–401
145. Truax, C. B., Carkhuff, R. R. 1967. *Toward Effective Counseling and Psychotherapy*. Chicago: Aldine
146. Truax, C. B., Lister, J. L. 1970. Effectiveness of counselors and counselor aides. *J. Couns. Psychol.* 17:331–35
147. Tseng, M. S. 1970. Locus of control as a determinant of job proficiency, employability, and training satisfaction of vocational rehabilitation clients. *J. Couns. Psychol.* 17:487–91
148. Ullmann, L. P. 1969. Behavior therapy as social movement. See Ref. 77, 495–523
149. Vontress, C. E. 1971. Racial differences: impediments to rapport. *J. Couns. Psychol.* 18:7–13
150. Warehime, R. G. 1971. Psychological interpretation and defensiveness. See Ref. 105, 51–57
151. Warman, R. E. 1960. Differential perceptions of counseling role. *J. Couns. Psychol.* 7:269–74
152. Ibid 1961. The counseling role of college and university counseling centers. 8:231–38
153. Warner, R. W. 1971. Alienated students: six months after receiving behavioral group counseling. *J. Couns. Psychol.* 18:426–30
154. Warner, R. W., Hansen, J. C. 1970. Verbal-reinforcement and model-reinforcement group counseling with alienated students. *J. Couns. Psychol.* 17:168–72
155. Watley, D. J., Kaplan, R. 1971. Career or marriage aspirations and achievements of able young women. *J. Vocat. Behav.* 1:29–43
156. Weiss, D. J. 1970. Factor analysis and counseling research. *J. Couns. Psychol.* 17:477–85
157. Wilcove, G., Sharp, W. H. 1971. Differential perceptions of a college counseling center. *J. Couns. Psychol.* 18:60–63
158. Yenawine, G., Arbuckle, D. S. 1971. Study of the use of videotape and audiotape as techniques in counselor education. *J. Couns. Psychol.* 18:1–6
159. Young, E. R., Jacobson, L. I. 1970. Effects of time extended marathon group experiences on personality characteristics. *J. Couns. Psychol.* 17:247–51

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VISUAL SENSITIVITY

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This review covers the period from the beginning of 1969 through the end of 1971. Its content is influenced by research trends reflected by work published in that period and by the biases of the reviewer. Although there has been great selectivity, the material included is still so broad that there has been little chance for penetrating evaluations. It is only hoped that this review may provide some useful direction to those who read it.

Numerous books have appeared since the beginning of 1969 relating to visual sensitivity. The second edition of Brindley's monograph (40) on the retina and visual pathways represents an updating of that work which will be particularly valuable for graduate level education. Another book of considerable significance is Cornsweet's *Visual Perception* (56). This provides an excellent foundation for advanced study of any aspect of vision. Books based on two international meetings will be of interest. Proceedings of the First International Symposium on Visual Science held at Indiana in 1968 include a number of useful papers (215). Some interesting work by Russian and German investigators on vision is included in the proceedings of a symposium which was held at the International Congress of Psychology in 1966 (97). Much of this work is otherwise unavailable in English. Other books of interest include a "how-to" book on visually evoked cortical potentials (VECP) (214), an introductory volume based on lectures of the late Gordon Walls (234), and an historical survey of the nature of light by Ronchi (229).

Sensitivity, as the word is used in vision research, applies to studies of minimum detectable quantities. The quantities are usually of light required for threshold detection or difference discrimination as influenced by the state of adaptation, the retinal locus, various parameters of the stimulus such as its size, its spatial character, and other considerations. The term sensitivity is also applicable certainly to other discriminations than those involving the intensity dimension, however. One may also measure threshold amounts of binocular disparity, change in wavelength, or change in retinal locus of a stimulus. Material that relates to sensitivity in the realm of color or depth discrimination has, for the most part, not been included in this review. These topics have been ably handled in the reviews of 1971 and 1972.

The spatial discrimination capability of the eye is perhaps the most importat characteristic of the sense of vision. It is not surprising, therefore, that a plurality of all papers surveyed over the past 3 years falls in this category. "Spatial" considerations have been largely with respect to projections within a frontal plane or in the image on the retina. The 1971 review of Spatial Vision (22) has, on the other hand, been concerned largely with the discrimination of objects in the visual world as these are distributed in depth. The authors of that review have suggested that relation of the psychophysical data of depth discrimination to the underlying physiological processes is an easier job at the present time than is the case for other aspects of spatial vision. This may be true, but the past 3 years have produced an extremely large number of attempts to bring about a rapprochement between the data of psychophysics and neurophysiology for aspects of spatial vision concerned with other than the depth dimension. Such attempts can be found throughout all aspects of vision research. The directness of the relation varies considerably, but many investigators are obviously anxious to somehow relate their findings in psychophysical experiments to the data of electrophysiology or vice versa.

SPATIAL CONSIDERATIONS

Not many years ago, this general topic was mainly concerned with such things as the size of the stimulus, its location on the retina, and visual acuity. In recent years, in addition to these classical considerations, much energy has been devoted to investigations of the spatial modulation transfer function of the visual system, and the influence of the size and orientation of targets that include line elements, particularly parallel line gratings.

Spatial summation.—Recent experiments confirm the well-established facts that spatial summation is greater in peripheral than in central vision and increases in the dark-adapted eye. Summation has been demonstrated to be proportional to the density of rod receptors in peripheral vision (188). The probability of detection of a luminance increment against a homogeneously illuminated background increases with increase in area of the increment stimulus. With increase in area, there is an increase in the perimeter of the test field, and efforts have been made to discriminate between these two characteristics (37). Variations in the perimeter and in perimeter-area combinations have not produced significant effects, however, and individual differences in the effects of these variables serve to complicate matters.

A study of spatial summation employing a flicker-fusion criterion determined the luminances necessary for fusion of a 28 Hz stimulus foveally and in two eccentric locations for a variety of stimulus sizes. For the sizes employed, the coefficient of summation showed a greater increase from fovea to 10° in the periphery with the smaller stimulus surface. There were no differences for subjects in each of three different age groups (165). Measurements of photopic increment threshold along the superior nasal, inferior temporal meridian showed a higher threshold for annular objects then for disks when each had the same total area. This was attributed to the reduction in spatial summation capability outside a central region of complete summation (295). The question of whether the summation area for blue cones is comparable to that for rods has been reexamined by Ruddock (235), who reports that the blue mechanism has a smaller summation area than that noted for rods.

There have been a number of investigations of the change in summation capacity of the visual system with changing adaptation. One question of considerable interest in this connection is that of the time course of the change. Hallett (112) reports that brief background changes which elevate threshold also cause a rapid decrease in the spatial integration capability of rods. A reduction in spatial summation capability may occur within only a few hundred milliseconds. Spatial integration capacity is not directly linked with the condition of adaptation as this may be revealed by threshold measurements. Integration capacity differs under conditions where threshold is rising as compared with others where threshold is falling. A study of visually evoked cortical potentials in man has revealed that response latency decreases with stimulus size and that initial response amplitude increases with stimulus size at all retinal locations. Latency increased with distance from the fovea (73).

Retinal perimetry.—Using a Goldmann perimeter, Lakowski & Aspinall (161) measured sensitivity of the visual field in the fovea and 20° and 50° in the periphery. They found that sensitivity improves from early youth up to an optimum age, reaching a maximum at the age of about 20, and then deteriorates with steady progression to advanced age. The difference between sensitivity early in life and at 20 years is greater in the periphery than in the fovea. It is suggested that results reflect a developmental factor. Measurements of threshold from the fovea out to 10° peripherally were made with white light and colored lights of two diameters for each of two durations in the dark-adapted eye—at a mesopic level and at a photopic level. Spatial summation was found to increase in the periphery under all conditions while temporal summation was approximately constant over the region studied. Within a central region of 4° diameter, it was found that the central 30 minutes may have very different properties from the rest of the region and a reduced sensitivity at all wavelengths in the dark-adapted state. Change in threshold with retinal location was significantly related to the wavelength distribution of the stimulus and the condition of adaptation (154).

If a near threshold test flash is presented to the retina repeatedly at 2-sec intervals, there is a gradual decrease in the probability of detection of the test flash over time. Data are extremely variable but have been fitted with an exponential function. The time constant ranges from 7 to 9 min for eccentricities up to 35°, is approximately 13 min at 40°, and varies from 19 min to 22 min between 45° and 60°. In addition to the declining trend, there appears also to be an oscillatory trend in the data with some periodic recovery of probability of detection (230). A study of the temporal summation capability of the eye at various retinal locations with a 7′ test spot has revealed that the relation between critical duration and eccentricity is rather complex. There is an increase in critical duration or time in which summation may occur out to about 5°, followed by a decrease to the edge of the blind spot. Two different observers have given quite different results with further increases of eccentricity (232). Ronchi (231) found threshold to be approximately constant along the horizontal nasal meridian for brief test flashes. For flashes of greater than 12 msec. sensitivity decreased beyond 40°. There is also evidence that the total integration time decreases for eccentricities greater than this. If the astigmatism for oblique rays is corrected optically, the total integration time reaches as long as 1 sec and sensitivity is increased (231). Wilson (313) has reported an increase in the area over which spatial summation may occur with increased eccentricity of retinal stimulation. Although the areas differ for different eccentricities, the Weber fractions are a constant for the maximum area at all eccentricities. Only one background luminance was employed. The sizes of the areas of maximum summation were found to be of the same order of magnitude as the sizes of the central portions of circularly organized receptive fields of the squirrel monkey at the same eccentricity.

Visual acuity.—The measurement of visual acuity by means of interference fringes created directly on the retina permits the determination of the resolution capacity of the retina independent of the limitations imposed by optical elements of the system (104). This may be particularly useful for determining the potential visual capability of cataract patients. Within the central 4° region of the retina, visual acuity is found to be very near theoretical limits based on the nature of the receptor mosaic. A comparison of acuity beyond 2° from the fovea measured by conventional methods and measured by interference patterns shows a reduction in acuity in the periphery, but the similarity of values obtained with the two methods requires a rejection of the notion that optical defects are a major cause of the decrease (105). Kerr (152) has reported higher peripheral visual acuity than that previously reported. She explains her results in terms of methodology. Schusterman & Balliet (246) have reported measurements of visual acuity in the sea lion which are about the same in air and under water. A visual angle of 5.5′ of arc could be resolved. Methling (189) has demonstrated that visual acuity for a stationary target and a moving target change in the same way with changes in luminance for velocities of the moving target up to 80° per second. It is concluded that within this range of velocities, limitations of acuity are not imposed by motion-induced reductions of contrast. An objective method for the measurement of refraction has been investigated using the visually evoked cortical potential (192).

Spatial sensitization effects.—Several experiments reported by Westheimer beginning in 1965 would appear to have had a highly significant effect on subsequent research. Westheimer (305, 306) showed that as the diameter of a background field increases, the increment threshold of a test spot in the center of the background also increases to a maximum value corresponding to some specific diameter of the background. For further increases in the size of the background field, the increment threshold of the central test stimulation decreases again. Increases in diameter causing elevated threshold were termed "desensitization" effects. Subsequent increases in background diameter that reversed this effect were termed "sensitization" effects. These effects have been demonstrated both for rod and for cone vision.

Teller and her colleagues have been most active in following up some of the implications of the Westheimer experiments. They have shown that the diameter for maximum threshold increment varies with the observer and that sometimes the diameter for maximum response or "peak" diameter becomes larger with decreased retinal illumination (278). Teller & Gestrin (277) repeated an earlier experiment by Westheimer (307) to determine whether the retinal activity which occurs during dark adaptation following light adaptation would influence a test flash in the same way that the activity engendered by a background field does with respect to sensitization. They found that presentation of a test field in the center of a region that had undergone prior light adaptation and was in the process of dark adapting produced the same results whether the field was of the size corresponding to background fields that resulted in desensitization or of a larger size which, in the case of the background field, would result in a sensitization effect. It is clear that the retinal activity during recovery from light adaptation, sometimes called "dark-light," does not have the same effect on an increment threshold as does light which is actually present. It has been demonstrated that in the near periphery the spatial parameters of interaction for the rods are different than those for the cones (308). The sensitizing interaction effects of the rod system are incapable of causing any sensitization within the cone system and vice versa. Within the foveal region, it has been demonstrated that the sensitization effects for the "red" and "green" mechanisms of the human eye are themselves independent (187). This was demonstrated by obtaining action spectra for the sensitization process under stimulus conditions that optimize respectively the "red" and "green" response mechanisms. Action spectra for effectiveness of the background in influencing the test field were the same as those for the two different cone mechanisms under the appropriate conditions of stimulation.

In another experiment, Westheimer & Wiley (309) found what appeared to be a second order effect, using a "satellite spot" instead of simply increasing the size of a background zone. Under conditions of scotopic illumination, they found a desensitization zone of 1° surrounded by a sensitizing zone that gave way to a second desensitizing zone. If a patch of darkness was employed instead of a light stimulus in the periphery, the sign of these effects was reversed. The usual interpretation of these effects is in terms of lateral interaction phenomena of an inhibitory nature. The central background region inhibits response to the test flash; the outer "sensitizing" annulus inhibits the background inhibition; and apparently a remotely located satellite spot inhibits the sensitizing annulus. It must be pointed out that Westheimer has used the term "sensitization" as an operational specification of his observations.

In a follow-up of the work reported by Westheimer in 1967 (306), Payne (211) has found a region of desensitization of 2.9′ diameter in the fovea accompanied by a surrounding region out to 10′ diameter in which illumination results in sensitization or reduction of increment threshold in the center. Payne has shown that intrusion into the sensitizing region of a black annulus is accompanied by threshold elevation. This confirms Westheimer's earlier report (306) that the simple presence of a border (1′ thickness) won't elevate threshold. Elevation occurs when the presence of the annulus reduces stimulation to the sensitizing region. The effect of the distribution of flux within a sensitizing annulus was investigated by Teller, Matter & Phillips (279). A sensitizing annulus was cut into eight sectors, and the distribution of flux was varied by blocking any illumination in certain sectors and increasing the luminance of others commensurately. It was found that distribution of flux more uniformly over the entire area had a greater effect in lowering threshold. Results were compared with the implications of Rushton's concept of retinal pools (236).

In a replication of some earlier work by Teller and her colleagues, Matthews (181) found that masking effects obtained with small disks yielded smooth functions while those obtained with larger disks were accompanied by on-transients. Temporal relations between a test flash and a sensitizing annulus were further explored in an experiment which showed that the threshold at the center of a steadily illuminated disk was a minimum near the instant of onset of the annulus (276). Maximum threshold was variable in time but occurred approximately at the instant of offset of the annulus. There is clearly not a comparable time course for this effect to the time course of threshold changes that occur in early dark and light adaptation. The results do not accord with the notion of some slowly propagated lateral effect within the retina. In a follow-up experiment, the entire background on which the test flash was presented was itself presented in various temporal relations to the test flash (280). For small backgrounds, there is an elevation of threshold according to a smoothly rising function. As the size of the background reaches the diameter beyond which sensitization occurs, there is an initial maximum in threshold corresponding to the onset of the background. Another maximum is found at the time of offset. Results confirm those reported by Matthews (181). These results may be contrasted with the effects of flashing just the sensitizing portion of the background which causes an immediate reduction in threshold of the test spot at the center of the field. Somehow the illumination of the immediate background of the test spot simultaneously with the "sensitizing" region is accompanied by threshold elevation rather than reduction.

In all of this work, there would appear to be the assumption, implicit or explicit, that the results obtained reflect the organization of retinal receptive fields. One way of testing this notion is to present the background or conditioning field to the other eye. This kind of experiment has been reported by Markoff & Sturr (176). The 3.5′ test flash was centered at various retinal locations and presented against backgrounds of varying diameter and luminance which illuminated either the same retina or the opposite retina. With increase in diameter of background, threshold rose and reached a maximum value for a diameter that was a function of the retinal locus. The greater the eccentricity of the stimulus, the greater the threshold value. Similar results were found for monocular and dichoptic conditions. Temporal characteristics of the conditioning flash were also investigated. Peak and threshold were found to be higher for transient than for steady conditioning fields, especially for dichoptic presentation of test and background. The results are interpreted to suggest that there may be cortical receptive fields with organization similar to those found in the retina.

The work of Westheimer and that which has been stimulated by it is frequently interpreted in terms of electrophysiological studies of receptive fields. Most electrophysiological experiments upon which our knowledge of receptive fields is based were done with quite different stimulus conditions, however, The nature of the receptive field has been explored with small spots, with disks, and with annuli, but the effect of presentation of an annulus on response to a test flash in the center is not the usual procedure. An electrophysiological study more nearly comparable to the sensitization experiment has been reported by Sakman, Creutzfeldt & Scheich (239). In the retina of the cat, there is apparently no effect on the response of a retinal ganglion cell to central receptive field stimulation which is comparable to the sensitizing effect of a surround in the psychophysical work. A later experiment by Maffei, Cervetto & Fiorentini (173) did show some analogous results to those reported in sensitization studies, but the stimulus conditions were quite different. Nakayama (197) has shown an interesting parallel of the sensitization effect, recording from cells of the lateral geniculate nucleus of the cat. It is suggested that the effect might be found in the retina by a careful examination of the statistical properties of the maintained discharge. This has not been done.

It would appear that the nature of retinal receptive fields has influenced a series of experiments, certainly with respect to the interpretation of their results, but that when highly similar stimulus conditions are employed in electrophysiological parallels of these studies, the expected results are not obtained. They have been obtained at the lateral geniculate nucleus, but psychophysical studies have shown that they may also be obtained when dichoptic stimulation is employed and, at least in man, this suggests cortical interaction. In spite of the unanswered questions concerning correct interpretation, the sensitization studies have provided a model for the development of a clinical testing procedure which has proven useful in the diagnostic discrimination of certain forms of pathology known to be retinal in origin (81).

Psychophysical studies of spatial interaction.—A variety of experiments has been reported concerned with variations in thresholds for detection of spots located in the vicinity of light-dark boundaries (199, 212, 213). The Hermann grid effect has prompted some of these studies. Spillmann (263) has employed variations of the Hermann grid as a basis for estimating receptive field size. There is considerable interest in the possibility of finding psychophysical techniques which will permit the measurement of propagation time of laterally acting neural events in the retina. One of the few studies of this sort which may have been successful was reported by Smith & Richards (255). There are other variations on the currently popular theme of attempting to relate psychophysical studies to the underlying neural organization (181, 243, 282, 285).

Receptive fields.—In the realm of electrophysiology, information continues to accumulate on the nature of receptive fields as a function of retinal location (136), the relations between center and surround of receptive fields for retinal cells (173, 174), the nature of fields for lateral geniculate cells and changes in the relative numbers of these fields which are found under anesthesia (270), and the characteristics of cortical cells in the waking monkey (315) and in the association cortex of the cat (71). A very complete account of the nature of the response for each cell in the retina of one species, *Necturus*, has been provided by Werblin (304). A formal model for interpretation of psychophysical studies based on receptive fields has been developed by Thomas (281).

The stabilized image.—The stabilized image continues to be of interest to many investigators. The question of where the phenomena observed with image stabilization are localized has been studied in several laboratories (30, 48, 58, 171, 203). There is considerable evidence that the process is not entirely retinal but at least partly central.

Simultaneous contrast.—The phenomena of contrast and constancy are closely allied both for color and for brightness. Demonstrations of contrast effects are easy to perform, and the invariance of relations among different portions of a visual scene has been studied for many years as the constancy phenomenon. Land has been particularly interested in these phenomena and has developed a model for their explanation. Of particular interest is the fact that the relative lightness or darkness of a portion of the overall visual field may be poorly correlated with the level of retinal illumination in the image of that portion. For example, two parts of a field which result in identical levels of retinal illumination may look very different in brightness or lightness. Such a situation may arise, for example, when there is a gradient of illumination of reflecting surfaces such that a surface of higher reflectance is illuminated at a lower level than another surface of lesser reflectance. Luminance of the two surfaces may be the same under these circumstances, but if the illumination gradient is continuous, the surface of lesser reflectance will appear darker (163).

Repeated judgments of brightness in a simultaneous contrast situation over a period of 5 days with no feedback to the subjects revealed a tendency for the brightness contrast effect to increase with repetition. Such findings pose a problem for theory (185). Quantitative studies of brightness pose a serious problem in controlling the basis for judgment. It is difficult to insure that an observer is responding on the basis of purely perceptual elements and not cognitive factors (167). The brightness of various parts of an overall presentation may be influenced by the amount of attention paid to them (85).

A variety of theories attempt to explain simultaneous brightness contrast. To a degree at least, many of these are descriptive of the known phenomena associated with the function of the visual system (85). Theoretical models provide a fit of the phenomena of contrast studies which result from variations in the differential luminances and spatial relations of a test situation (247, 301). Theories of contrast may involve a variety of hypothesized mechanisms or may call upon known physiological mechanisms as a basis for explanation. The important questions which must be asked are how adequately they fit the data, the extent to which they are suggestive of new experiments which will test their implications, and the extent to which their physiological bases, when these are significant, accord with known facts from the physiological domain (259). Answers to these questions are not always obtained devoid of controversy, however (92, 93, 138).

Recording from the lateral geniculate nucleus of the monkey, DeValois & Pease (67) observed the responses of single units to a variety of stimuli associated with contrast effects. Border enhancement was found in the case of luminance contrast figures but not for color contrast figures. Uniform brightness contrast effects over an entire stimulus field were not associated with a uniform increase in cell discharge for all positions of that field on the retina relative to the receptive field of the cell. It was concluded that some aspects of simultaneous brightness contrast must be mediated by cortical processes. Simultaneous brightness contrast involving rods was explored by appropriate selection of stimulus, luminance, and wavelength (128). Brightness contrast judgments and increment thresholds, as both of these change with increase in the background luminance, were found to yield very similar functions (311). A technique is described for the use of flashing lights which results in brightness judgments that are independent of backgrounds presented to the contralateral eye. It is assumed that the technique permits the measurement of purely retinal effects.

Mach bands.—Several papers have offered interpretations of the neural systems that underlie Mach bands (65, 99, 310). As this phenomenon is examined more carefully, it becomes apparent that a quantitative description in terms of fairly simple spatial interactions in the retina probably is not possible.

Line patterns.—As mentioned above, many of the research reports published in the past 3 years reflect an interest in the relation of neurophysiological and psychophysical findings. One area for which this is especially true is that of the discrimination of line patterns. The question of whether there may be orientation specific detection mechanisms tuned to narrow bands of spatial frequencies has been investigated extensively (26, 32, 34, 49). There appears to be evidence for mechanisms that respond to spatial frequencies of between 3 and 14 cycles per degree which are orientation specific (26, 32). The effects of adaptation of one eye may be detected in the other and effects are highly specific for line pattern orientation (26). Both of these results implicate the cortex. Some of the results of employing stimuli comprised of two sinusoidal components of different frequency support the notion that there are multiple response channels functioning independently (47, 103, 238). Analogous results from single cortical cells of the cat tend to support this conclusion (44). If an adapting grating differs in orientation from a subsequently viewed test grating, there is less reduction in sensitivity for the test grating than when the alignments of the two are the same (31, 100, 101). Differences in orientation between adapting and test gratings or of two different line elements or grating patterns seen simultaneously produce an alteration in the perceived orientation (27, 36, 194). Horizontal and vertical lines appear to have a more potent effect in influencing the orientation of other lines and are themselves less influenced by the orientation of other lines (36). The effect is to increase the apparent difference in orientation of patterns which have some actual orientation difference. Most of the effect of one pattern of lines on another appears to be gone by the time the difference in orientation reaches 10 to 15 degrees (101). It has been reported that there is no effect of a horizontal line on a vertical line (32). On the other hand, it has also been reported (46) that slight deviation of a pattern from horizontal will cause an apparent deviation of a vertical pattern from the vertical. The relatively greater effect of vertical and horizontal line patterns in influencing apparent orientation of other patterns of slightly different orientation may be compared with the fact that the evoked cortical potentials which result from stimulation by a moving grating are significantly greater for vertical and horizontal orientations of the grating than for oblique (172). There is some evidence to suggest that body tilt may also influence the optimum orientation of a line pattern on the retina for stimulation of specific cortical cells (129).

There has been some criticism of interpretations of pattern experiments because they seem to imply specific neurological mechanisms (314), whereas the results may arise from methodological errors and omissions.

Techniques of frequency analysis have been applied to spatially distributed stimuli to the visual system. From a knowledge of response to sinusoidal patterns of stimulation, it has been possible to compute the threshold contrast for aperiodic patterns (43) and the effects of employing sharp edges in the delimitation of a sinusoidal grating stimulus pattern (149). The spatial modulation transfer function of the visual system has been investigated under a variety of conditions (64, 216). Some of the mechanisms which influence visibility of gratings have been discussed by Fry (95). Exaggerated eye movements have been found to reduce sensitivity for low spatial frequencies (160). On the other hand, it has been reported that evoked potentials are smaller for low frequency, high amplitude stimulation when the image is stabilized, and that higher amplitude responses are obtained for higher order components of the stimulus with a stabilized image (146).

Changes in spatial resolution capability of the retina with a variety of conditions are often associated with a similar change in temporal resolution capability. Kulikowski (159) has recorded some results which suggest that visual and temporal resolution demands on the system may act on a common mechanism. For a given level of stimulus contrast, the sum of spatial and temporal frequency values, appropriately weighted, was found to be a constant. A gain in one could be achieved only at the expense of a loss in the other. The work of Muir & Over (194) suggests that the separation in space of line patterns is an important parameter in the tilt aftereffect.

Several experiments involving line patterns have been combined with other variables. The possibility of independent mechanisms for adaptation effects involving movement (209), as well as the possibility for interaction between rate of movement and the spatial frequency of a grating pattern (207), has been investigated. Investigation of adaptation effects involving line patterns with various colorations of the illuminant have been of great interest since the original report of the McCollough effect (186). There is a suggestion that Emmert's law may not hold for McCollough afterimages (195), presumably afterimages which result from conditioning of central mechanisms. These aftereffects are associated with cortical edge detectors (86), but analogous effects can be demonstrated with a variety of patterns (274). These effects may last as long as 6 weeks. Variations in the way in which induced colors may be achieved have been reported (273). It has also been shown that a kind of spatial integration effect which is involved in the discrimination of grating patterns may differ with changes of the wavelength of illumination (87).

Electrical responses to pattern stimulation.—In the years covered by this review, there has been considerable interest in the cortical potentials evoked by various forms of pattern stimulation. A brief review of some of the procedures employed for studying both retinal and cortical potentials has been presented by Riggs (225). The patterns most widely used for the evocation of cortical responses have been line gratings and checkerboard patterns. The amplitude of cortical responses depends upon the size of the stimulus, the sharpness of the retinal image, and the visual acuity in the portion of the retina stimulated (121). The region of the retina stimulated is particularly important (118, 139). As the stimulus is presented at increased distance from the fovea, the optimum size of a pattern increases out to at least 12° or more eccentricity (118). There is evidence that the stimulation of the upper retina results in larger responses than comparable stimulation in the central portion of the retina which in turn yields larger responses than those obtained with stimulation of the lower retina (74). Differences in response have been associated with the horizontal and vertical meridians of the visual field (114, 172). Larger responses are reported for stimulation closer to the vertical meridian, and a polarity change has been observed for a transition of the locus of stimulation from the upper to the lower field (114). The amplitude of the potential which is evoked by a grating pattern increases with the logarithm of contrast of the pattern. This relation is relatively independent of the spatial frequency of the pattern. However, if the pattern consists of the addition of two spatial frequencies, the increase in amplitude with contrast is significantly steeper, and the slope is even higher if three different frequencies are added (45).

Adaptation effects reveal orientation and frequency specificities. Orientation may not differ by more than 15° in either direction and frequency by an octave or more without virtually complete attentuation of adaptation effects (45). These results are interpreted to support the notion of tuned channels for spatial frequency detection in the visual system. The optimum size of a stimulus pattern dedependent upon the location on the retina stimulated would appear to be linked to the way in which receptive field sizes change with retinal location. Optimum size is smaller for maximum "off" response than for maximum "on" response. This may be associated with differences in size of "on" and "off" center receptive fields or with some sort of adaptation effect of the stimulus (119).

VECP amplitude is highest for target element separation of about 9′ (119). Changes in apparent size of a pattern which result from changes in fixation distance and convergence are not accompanied by changes in evoked potentials, however (221). Closer grouping of elements within a pattern tends to reduce the evoked potential (20). Evoked cortical potentials have been measured in infants, and it is reported that the optimum stimulus size becomes smaller as the infant matures, presumably reflecting development of the visual system and improved visual acuity with age (120). A comparison of the responses to patterns of checks and stripes shows that they produce approximately equal amplitude of the ERG for the same spatial frequency of the stimulus. There is a much more prominent peak response to stimulation by checked patterns than by striped patterns in the VECP. Evidence for tuned receivers from work with the VECP is not found in simultaneous recordings of the ERG (11).

RETINAL PROCESSES

Cone processes.—Studies of the late receptor potential under photopic levels of adaptation have shown that mechanisms exist within the retina for setting gain of the system dependent on background level while maintaining a nearly linear response over an appreciable range of luminances about that level (38). A significant role for receptors themselves in adaptation must be recognized (cf. 102). A determination of equivalent background levels for each of two target diameters during cone dark adaptation revealed that no single equivalent luminance would serve with variation in the size of the test stimulus (226). Comparative studies of the Stiles-Crawford effect based on a flicker criterion and a measurement of the rate of cone bleaching revealed excellent agreement and prompted the conclusion that the bleaching of cone pigments must, in fact, occur in the outer segments of these receptors where the light is employed for vision (54). Using a method reported earlier by Alpern—the contrast flash procedure—Alpern, Rushton & Torii (6) studied the responses of red and green cones. They concluded that responses are very similar to those of rods, except that approximately 100 times as many quanta are required for the same effect.

Rod responses.—Using Alpern's contrast flash procedure, Alpern, Rushton & Torii have studied the amplitude of rod responses (3), the way in which rod responses are attenuated by background illumination (4), and reduction in rod signals resulting from bleaching, even at levels above the cone threshold (5). The logarithm of threshold is raised 1.2 units for each 10% of pigment bleached. An equation which provides a satisfactory description of the elevation of threshold with bleaching is presented. Alpern (2) has presented additional evidence for the complexity of the physiology of the relation between threshold and the time course of rhodopsin resynthesis. The significance of the pattern of bleaching on the retina has been studied by Andrews & Butcher (8), who have shown that the effect of rhodopsin bleaching extends over the retina for a distance of 2.5°, but the effect is rapidly attenuated, being reduced by a factor of 10 for a separation of only 15′. Influence of scotopic vision on the electroretinogram at photopic levels is implied in the results of Walters (297). Reduction of the frequency and shortening of the wavelength of the stimulus is accompanied by increased B-wave activity. Very rapid changes in the nature of response of the dark-adapted retina have been demonstrated with presentation of parallel line patterns and black disks (112). Under conditions of rod sensitivity, presentation of a repetitive stimulus to the eye of the cat is accompanied by a relatively large response to the initial flash with a reduction in amplitude to subsequent flashes, followed by a gradual recovery (240). Responses of the rod system were studied by recording from the lateral geniculate body of the cat (66). Results indicate a saturation of the rod response, but this is apparently not a result of cone suppression. It is only found in animals with cones, however.

Mesopic vision.—The Purkinje Shift has been studied in both normals and tritanopes (130, 131). There appears to be little difference between either the rod spectral response or the cone spectral response of the tritanope and the corresponding response of the normal, but the transition from one to the other with change in adaptation shows a quite different course in the tritanope, requiring a significantly higher luminance before the transition is accomplished.

Electrical evidence for rod-cone interaction.—It has been shown that the slow potentials evoked by light stimulation in the retina of the cat may arise from either rod or cone stimulation or a combination, depending upon adaptation and the wavelength distribution of the stimulus (268, 269). Under mesopic conditions of illumination, the spectral response function of optic tract fibers of the cat appears to reflect the activity of pigments absorbing at peak wavelengths of 556 nm and 507 nm. As luminance level is reduced, dependence of the function on the shorter wavelength receptors appears to increase and more of the units are dependent exclusively upon the function of rods alone. Similar results are obtained at suprathreshold levels. Rod responses are distinguished from those of cones by their longer latency and larger areas of response. It is suggested that the color discrimination capability of the cat may depend upon the relative levels of cone and rod input (9, 10, 115, 116).

ADAPTATION

Dark adaptation.—Threshold during dark adaptation decreases as the quantity of bleached pigment decreases with regeneration. The time course of recovery is somewhat different following very short bleaching flashes than after longer ones (237). Both objective and subjective measurements of the recovery of sensitivity during dark adaptation reveal that there is a change with age, the lowest thresholds being found in observers approximately 20 years old (294). The rate of recovery also is found to increase with age up to approximately 20 years. An interaction process between the two eyes during dark adaptation has been reported. Adaptation and testing of one eye alone shows a slower course of recovery than for adaptation of both eyes with testing of one (164). The use of deep red goggles for preservation of low luminance sensitivity is a practice of long standing. The importance of examining carefully the exact nature of the visual task for which sensitivity is to be preserved has been emphasized by a recent experiment (50). The optimum spectral transmittance of goggles varies with the task. The possibility that more than two mechanisms may be revealed by the form of dark adaptation curves is not new, but some additional data have been published on this question (98).

Dark adaptation in animals has been studied with a tracking technique, and comparative studies of human observers have been made with the same apparatus for comparison both with the squirrel (69) and with the cat (162). There are some differences between results for humans and the animals in each case, but in the results for the cat it is fairly evident that results are more nearly like those of the human observer than like those which have been reported earlier for single cells of the cat visual system (15).

A test of the possible inhibition of cones by rods when the latter achieve sensitivity during dark adaptation has shown that such inhibition does not occur, at least for measurements based on a spatial resolution criterion (41). The sensitivity of the retina may be altered by flashes of light in regions other than that tested. Effects of this sort and their relation to wavelength of test and adapting flash have been reported (155). A retinal model for adaptation has been proposed by Leibovic (166).

Electrical correlates of adaptation.—At low levels of illumination there is an increase in the activity of single units of the retina of the cat with increased levels of illumination. In this low range of illumination, there is no inhibitory surround activity. At higher levels of illumination the single unit activity level ceases to reflect further increases in illumination and the surround exerts a sustained inhibitory effect on the unit (16). Adaptation processes are obviously quite complicated. As mentioned above, the presentation of a line pattern to the retina may cause an almost immediate change in the spatial integration capacity of the system (113). It has been shown that the response of a unit in the cat retina occurs with a latency which is dependent upon the sum of the steady background illumination and the test luminance presented. This could only be true if there is some mechanism which achieves a resetting of the system within the latent period of response to the test flash (53). Studies of the response of specific cells in the retina of *Necturus* have provided fairly compelling evidence that the b-wave of the electroretinogram may have its origin in the activity of glial cells (191).

TEMPORAL FACTORS

The second largest body of research concerned with visual sensitivity involves manipulations of the various temporal characteristics of adaptation, stimulation, and the intervals between test and conditioning flashes.

Temporal summation.—Some of the work which has been done in recent years suggests that the concept of a critical duration, within which total energy is the relevant variable independent of the nature of the temporal distribution of energy, is much too simple. Although there may be a critical duration for the criterion of detection, the activity of the nervous system when stimulated at this threshold level may not be identical when the time course of energy input is changed within this time period. At a near-threshold level, subjects are capable of discriminating between longer and shorter test flashes (316). Temporal summation occurs between a fixed subliminal conditioning flash and a variable test flash when both are presented to the same eye and when each is presented to a different eye, although the summation is greater for monocular stimulation (17). As the interval between presentation of conditioning and test flash is extended beyond 20 msec, complete summation gives way to partial summation. With a 5 msec test flash and a conditioning flash of 10 msec or longer, minimum test flash energy is required when the test flash is presented at about the middle of the conditioning flash. Complete reciprocity would appear to be limited to about 10 msec at an adaptation level of one mL. Earlier studies which show longer intervals for complete reciprocity were done with subjects completely dark adapted (17, 18). Correspondence between the limits of temporal integration for a stimulus which drives the pupillary light reflex and for visual perception suggests a single neural processing system beyond the receptors for each of these functions (302). When two flashes are employed to study temporal summation, it is found that they may be mutually inhibitory when presented at certain intervals (106, 289). The inhibitory process takes place over a longer duration for lower adapting levels (289). Rashbass (218) found similar temporal integration effects for increments and decrements of stimulation. With two brief flashes, summation was incomplete at 10 msec and no summation was found at 65 msec. An increment and a decrement occurring quite close together in time negate each other, but may complement each other for longer intervals, maximally at 65 msec separation. A band-pass filter model is proposed to account for results.

Flicker.—In a series of papers, Kelly (147, 148, 150, 151) has developed a model which provides an economical description of a variety of phenomena associated with flicker experiments. A lateral inhibitory process is invoked to account for effects associated with changes in the spatial pattern of stimulation. These effects are manifested at low frequencies. The mechanism for detection of flicker is assumed to be located more centrally than inhibiting mechanisms, at the level of ganglion cells or beyond. High frequency effects are attributed to a linear filtering process associated with diffusion within the receptor cell itself. Studies of responses of the visual system with uniform fields and with counterphase gratings at various adaptation levels have produced results which can be described by manipulation of a gain factor and the number of neural inhibiting units in series.

Adaptation to a flickering stimulus influences the threshold for the discrimination of flicker. Several recent papers report variations on this phenomenon (208, 253). In early studies of this effect, the dependent variable was fusion frequency for a given luminance level. In more recent experiments, the threshold is measured in terms of modulation amplitude, and it may be impossible to associate frequency of the adapting stimulus with the effect of adaptation at various test frequencies. In any case, Smith (254) does not believe that his results support the notion of separate channels for the detection of flicker in different frequency regions. Studies have confirmed that the spatial form of a flickering stimulus is an important variable (228). There is a change in the critical frequency of fusion with viewing distance, with frequency rising as distance increases (122). It is suggested that the functional size of receptive fields may become larger with increasing accommodation and convergence. This kind of effect has been predicted by Marg & Adams (175) in explanation of size constancy. Size judgments of afterimages which are probably central in nature appear to differ significantly from those of more peripheral effects with changes of distance (195).

The effect on flicker sensitivity of a surround has been studied over a wide range of luminances (123). The dependence of the visibility of flicker on waveform and effects of changing frequency at suprathreshold levels continue to be demonstrated (13, 21). Such effects have proven amenable to understanding in terms of Fourier analysis in recent years, but this useful technique continues to be neglected.

Independent stimulation of the two eyes provides a basis for inferring location in the nervous system at which threshold effects are determined. The phase relation between flickering stimuli to the left eye and the right eye for maximum and minimum sensitivity has been interpreted in terms of possible hemispheric differences in the mechanism of flicker resolution (55). The effect of flicker, studied in terms of a test flash presented against a background of multiple flashes, indicates a greater change in the threshold of the test flash with greater spacing of the background flashes, maximum test flash elevation occurring when test flash is presented proximal in time to a background flash (19). These effects are observed for both monocular and haploscopic presentation, although greater for monocular. These results imply a central processing mechanism. Effects of an intermittent stimulus, even though it appears fused, on a superposed test probe for monocular stimulation but not for binocular stimulation indicates that other mechanisms of a more peripheral sort are involved. Changes in the form of the temporal frequency response function with stimulus size have been interpreted in terms of inhibitory interaction in receptive fields (88). Over a certain range of frequencies, up to 15 Hz, temporal variation of the stimulus may enhance the visibility of spatial detail in a stabilized target. Higher frequencies of time variation may be perceived as flicker but do not enhance the visibility of edges (144). The presence of a continuous surround greatly enhances the low frequency sensitivity of the visual system to flicker in a small, centrally located field. Separation of the surround reduces its effectiveness in elevating the low frequency sensitivity (145). A careful evaluation of threshold of a test flash presented against a flickering background reveals variation in threshold with phase of the background at time of test presentation, with minimum threshold coinciding with minimum background luminance. Maximum threshold precedes maximum background luminance, however. This phase lead increases with frequency, reaching a maximum of about 90° at 5 Hz (250). It is suggested that the nature of the masking effect of a flickering stimulus is compatible with a locus of the effect at the ganglion cell level.

A visual beat phenomenon achieved by the presentation of two stimuli at different temporal frequencies has shown the perceived beat frequency to correspond with the physical beat frequency for various retinal locations. It is concluded that temporal resolution capability is uniform over the regions of the retina studied (143). Wide variations in the brightness of dichoptically presented stimuli do not affect visual beats (142). Brightness is influenced by frequency of the stimulus components and beat frequency. It is concluded that temporal processing is somewhat independent of brightness registration for flickering stimuli. The ability to detect discontinuities in a temporally varying stimulus is better when the stimulus is confined to a single retinal region as contrasted with the presentation of individual flashes to different loci (291).

Differences in the temporal response properties of different color systems continue to interest investigators (84). Color fusion for dichoptically presented stimuli has been studied for a variety of temporal characteristics of the stimulus and various temporal relations between the presentations to the two eyes (200). Variation in the rate of presentation of a monochromatic stimulus may be accompanied by a shift in hue (198). Maximum amounts of shift were found for wavelengths between 525 nm and 550 nm and at 650 nm. These shifts are not related to those induced by luminance and may arise by reason of the same mechanisms involved in the production of Fechner colors. Brightness enhancement effects associated with changing stimulus frequency do not show wavelength dependence (292). A technique for the assessment of the contribution of spectral character of the stimulus to the perceptibility of flicker has been outlined by Ikeda (135).

Intersensory influences on flicker have been described in which auditory (190) and thermal (168) stimulation may enhance sensitivity to an intermittent stimulus. Spatial discontinuities may appear in a physically uniform stimulus pattern which is presented intermittently (222). The luminance at which this kind of effect occurs varies with frequency and also with wavelength distribution of the stimulus or of a preadapting field.

Study of the effects of intermittent stimulation need not be restricted to conditions which produce fusion. Temporal response of the system as influenced by a variety of conditions may also be studied in terms of various criterion levels of flicker appearance. Sensitivity based on the estimated depth of modulation has been investigated for various luminances over a range of frequencies by Marks (177).

Latency.—Studies have shown that the latency of response to a visual stimulus is reduced by the addition of a surround and is reciprocally related to the luminance of the surround. This is true even at surround luminances that may result in reduced sensitivity for the test stimulus (179, 180). The increased latency of the visual system with a reduction in luminance has been ascribed primarily to adaptation phenomena (217). Very similar changes in reaction time to increment and decrement stimulation with changes in stimulus duration have been interpreted to imply that the same mechanism may be involved in temporal summation in both cases (271). One experiment has shown a more rapid response to stimulus offset than to stimulus onset (117). The fact that this relation is not influenced by background level was interpreted to indicate that it is not influenced by adaptation, but the foregoing test flash itself may conceivably have a rapid adapting effect (53).

Persistence of vision.—A variety of experiments over the years has shown that the duration of visual perception of a test flash probably reaches some minimum value as flash duration is reduced and remains approximately fixed at that level as test flash duration is further reduced (75–77, 108). Although this visual persistence is of several hundred milliseconds duration, asynchronies in visual stimulation may be detected within a much shorter range (290). Changing critical duration with luminance suggests that the discrimination of differences in duration may be influenced by luminance level, but there is some indication that discriminations of duration differences do depend on temporal characteristics (1). Response to a visual stimulus may continue for several hundred milliseconds after it is presented but the response may be cut off by presentation of a succeeding flash (261). Use of the appearance of a continuous arc as a criterion of persistence when a stimulus is rotated in a frontal plane continues to provide a useful method for studying the temporal processes of vision (256, 257). Differences in apparent position of moving stimuli as a function of their luminance have long been studied in association with the Pulfrich phenomenon Whether these differences provide a basis for inferring the location in the nervous system of the increased delay associated with the decreased luminance (312) is open to some question.

Backward masking.—Studies of backward masking include an extremely broad range. In the simplest studies the threshold for a test flash is elevated by a masking flash presented after the test flash. Spatial location, size, and temporal relations may be varied almost infinitely. Beyond this, the spatial dimension has been investigated for a variety of patterns of test and masking stimulus including abstract symbols, numbers, letters, and words. Space does not permit the consideration of such complex material here.

Masking is very much influenced by relative spatial characteristics of the target and the masking stimulus (242). As a larger masking disk becomes closer in size to a target disk, the masking effect is increased. An annulus appearing around the masking disk reduces masking. Such a result suggests the possibility of a lateral inhibition process. A black ring masks more effectively when its inner diameter is decreased to the size of a black target disk diameter (61). The changes in the amount of masking with target mask separation permit an estimate of the radius of an inhibitory region that is similar to estimates obtained with other experimental procedures (60). The masking effect of a surrounding ring on a central disk with the masking stimulus delayed does present some problem in a lateral inhibition interpretation, however. Retroactive masking may also be obtained when the masking stimulus is of the same configuration and presented to the same retinal locus as the test stimulus. Stecher (265) has implicated central processes on the basis of an experiment of this sort. A study of the summation of two flashes presented during the interval prior to a masking stimulus when sensitivity of the eye is changing has found that the contributions of the two stimuli are weighted in accordance with sensitivity (153).

The spatial characteristics of the test field and the mask influence results significantly in backward masking. If a single vertical line element is used as a test field, the orientation of a single masking line influences the masking effect. Test line threshold is increased maximally when the masking line is made more nearly vertical. Detectability of the test is decreased the most when the masking line is of about the same length as the target line and illuminates closest to the same position as the target line (210). If the mask is a ring surrounding a disk, the masking effect of an incomplete ring is greater when the ring is comprised of four segments symmetrically located than when a single continuous segment of the same total length is employed (248). A target disk divided into half white and half black is more difficult to mask than a homogeneous disk (249). The greater the amount of internal contour in a target, the less susceptible is the target to backward masking (59). Thus, increased internal contours of a target may be accompanied by enhancement of its detectability when a backward "masking" stimulus is presented (78). For spatial frequencies of .25, 1.0, and 4.0 cycles per degree, however, there was no effect on the apparent contrast of the pattern when a backward masking stimulus was presented. A "masking" flash preceding the target was accompanied by increased contrast (57). Some of these results suggest the involvement of cells specialized for the discrimination of line elements. A similar involvement may account for a reduction in the sequential blanking effect involving two of five outlying squares when the blanked squares were altered so that they appeared as trapezoids (184). Manipulation of the position of the two blanked elements in the five-element blanking sequence has provided some information about inhibitory fields in man (243). A U-shaped function has been found in backward masking and a similar function has been found for a variety of conditions in the sequential blanking paradigm (7).

The interpretation of backward masking and sequential blanking in terms of a kind of inhibitory process which could, in turn, be inhibited has met with both support and challenge (183, 245). The interjection of dark intervals into a stimulus sequence may have various effects depending upon the duration of the dark interval and other conditions (14, 244). It has been demonstrated that the effect of a masking flash which follows a test flash may be enhanced, or the probability of detecting the test flash further reduced, by the presentation of an electrical stimulus to the septal and reticular regions. This may be interpreted to support the argument that masking effects are central. The electrical stimuli had no effect on the test flash alone or the appearance of the masking stimulus alone (96). An interesting comparison of behavioral and electrophysiological studies of masking, both backward and forward, and metacontrast has been made by Schiller (241).

Metacontrast.—Metacontrast, as the term is usually used, differs from backward masking in that it is measured in terms of effect on the brightness of a test stimulus rather than on its threshold. It may be measured by adjusting the luminance of a test flash so that its brightness matches a fixed reference or the converse. Using the first procedure, Matteson (178) investigated the effect of surrounding masking stimulus diameter and found an increase in the metacontrast effect with increased diameter. The results were somewhat variable, however, In a later experiment, the same method yielded fairly reliable results, but when an effort was made to match the reference to the test simulus, there was much more variability (91). A U-shaped function for the metacontrast experiment has been reported both with a forced-choice technique and with a magnitude-estimation technique, leading to the conclusion that the form of the function is therefore not strictly dependent upon a subjective response criterion (303). A theoretical model based on a neural inhibitory network has been proposed for the explanation of metacontrast and various kinds of masking (39).

LUMINANCE DISCRIMINATION

The luminance necessary in a test flash for its discrimination against a background field, or the amount of increment necessary for the detection of a luminance change in a given field, provides a widely used index of the sensitivity of the visual system as influenced by a variety of variables. Rod vision may be studied selectively by appropriate choice of conditions (109, 110). The form of a stimulus and gradients of luminance within the stimulus field may influence luminance discrimination thresholds (283). When the stimulus includes discontinuities of luminance such that certain regions are at a higher flux level than others, relative size of the specific regions also influences threshold. Increases in luminance of a portion of the field relative to the remainder may, in some instances, result in a threshold elevation (12, 284). Elevation of threshold by increasing the relative luminance in flanking portions of a stimulus field is attributed to lateral inhibition. Demonstration of this kind of effect at the approximate level of the forced-choice threshold has been invoked to contradict Blackwell's suggestion (23) that lateral inhibition effects are not found at the threshold level (284).

Evidence has been presented that the suppression occurring during binocular rivalry is a generalized inhibitory state applying to all types of stimulation falling within the region of suppressed vision (296). An analysis of luminance discrimination data taken over a series of days reveals a fairly substantial change in threshold level from day to day which may be influenced by changes in conditions as well (111).

The ability of animals to make luminance discriminations has been studied extensively as a possible indicator of a variety of effects. The methods employed in such studies are quite important, and it is dangerous to draw a conclusion on the sensitivity of the visual system of an animal relative to that of man, for example, when differences may be the result of the procedures employed rather than the inherent characteristics of the visual system (286). Over the years, a number of investigators have attempted to find some behavioral index of the vision of *Limulus*. Recently, an unconditioned tail movement has attracted some attention as a possible indicator of response to abrupt changes in illumination of this animal (300).

Discrimination of luminance differences is a fairly gross function and may be insensitive to such manipulations as deprivation of stimulation (275) and various forms of surgical intervention in the visual nervous system (272). Often learning may be influenced by such intervention without any evidence that the ultimate discrimination capability of an animal is changed significantly.

Luminance discrimination studies have provided the data for several examinations of the applicability of signal detection theory in the description of the function of the visual system (158, 196, 288). Models involving excitatory and inhibitory interaction processes are probably still the most common (156).

SPECTRAL SENSITIVITY

In recent years, with an increase in confidence as to the nature of the spectral absorption characteristics of the pigments that reside in individual cones, there has been an increased interest in the way in which the function of these cones is combined to produce the photopic luminosity function. Working with monkeys, Sperling & Harwerth (262) have employed an increment threshold technique to measure spectral sensitivity. They have shown it possible to fit their results by combination of individual spectral response functions for cones using linear difference functions in the green and red regions and the sensitivity of a single class of cones alone in the short wavelength region of the spectrum.

Electrical indices have been used more commonly than behavioral indices in studies of infrahuman organisms. In the rhesus monkey, spectral response of the system has been measured in terms of the ERG and the VECP. The function of rods is a more prominent influence in the ERG, while that of cones is more prominent in the VECP. For the owl monkey, the scotopic system dominates both of these indices (227). Investigation of the influence of various levels of the ERG as response criteria has resulted in identical curves for all levels investigated in the macaque (293). When the spectral response of single cells of a nonopponent nature in the lateral geniculate nucleus is measured, relatively broad response functions are found suggestive of the combination of responses from several different classes of cones (137).

The visually evoked cortical potential has become of increasing interest in recent years as an index of function of the human visual system. Regan (220) has shown that the frequency of a time-varying stimulus is an important variable in determining the qualitative nature of results with the VECP. The amplitude of harmonic components from 45 Hz to 55 Hz showed a minimum value which compared closely with the conditions for a subjective minimum in flicker. This was not true for other frequency ranges. By the use of the appropriate frequency range, objective data based on the VECP were obtained which agree with psychophysical results to within 18%.

Using a 40 Hz stimulus, spectral sensitivity and the effects of chromatic adaptation have been measured in terms of the electroretinogram. Results were in good agreement with psychophysical studies (205). Measurements of the spectral sensitivity of the human observer with a visually evoked cortical potential are being made with striated patterns, the positions of which may be shifted on the retina to provide stimulation (182). In this way, the average illumination may be held constant and the possibility of extraneous results from changing level of stimulation or from scattered light is avoided. Response can be measured in terms either of latency or amplitude, and data have been found to be in fairly good agreement with the results of psychophysical investigations. An alternative method is the alternation of a white and chromatic component at a rate of approximately once per second (252). Several studies have appeared in the literature in which behavioral techniques for the measurement of spectral response functions have been employed with animals. Techniques include the use of reaction time as a criterion of stimulus level at various wavelengths (193), and operant conditioning techniques (162, 233). Behavioral studies in animals are particularly useful for the interpretation of electrophysiological studies (258). Microspectrophotometric studies of the pigment densities in individual receptors are continuing (70), and it is reasonable to expect that improved and refined measurements will become available.

PHOTOMETRIC MEASUREMENTS

A major problem in photometry rests with the difficulties encountered when heterochromatic components are employed. Models have been devised to cope with additivity failure under heterochromatic conditions (298) and superadditivity (299). A vector model has been proven useful by Guth and his colleagues (107). Of particular interest in this connection is the fact that the nature of functions derived from threshold measurement obtained when different color components are added may be used as a basis for deriving functions which are almost identical with those based on color mixture.

Photometric measurements are very frequently based on a brightness matching procedure (206). Another technique which has been described in recent years is that of "minimum border contrast" (140, 141). Instead of attempting to match brightness, the observer attempts to minimize the border between two adjacent fields. For minimum border, a brightness difference is usually detectable when the colors of the two fields are not the same. While additivity breaks down for spectrally different components which are measured by brightness matching techniques, additivity has been demonstrated to hold for the minimum border contrast techniques. The technique of minimum border contrast judgment yields results similar to those obtained with heterochromatic flicker photometry. A variety of ratio estimates and direct magnitude estimate techniques has been employed for the evaluation of brightnesses (63, 82, 204). The concept of equivalent luminance designation for chromatically different stimuli has been recommended (157). Measurements for a variety of chromaticities and luminance levels have provided direct information for this kind of procedure.

RADIATION

The human visual system can be stimulated by particles and by electromagnetic radiation outside the visible spectrum. Experiences of astronauts have prompted the investigation of possible mechanisms by which the eye may be stimulated by fast neutrons, X rays, and positive pion beams (287). Exposure to neutrons of energies below 25 mev may result in the appearance of starlike flashes and short streaks. It is suggested that alpha particles released from neutron reactions and recoiling protons may interact with the retinal rods (42). Primary cosmic radiation has been proposed as the probable source of light flashes observed in lunar flight (83).

BRIGHTNESS

There is no way in which the subjective response to illumination in the visual field can be predicted directly from the physical characteristics of the field. Condition of the observer with respect to adaptation is also important. Beyond this, the way in which he interprets the field may also influence his impression of brightness. The usefulness of the term "brightness" resides in the fact that it describes what is apparent to an observer as distinct from what is present physically, even when such factors as background, size and other physical parameters are taken into account. In spite of this, many investigators persist in the use of the redundant expression *apparent brightness*.

Distinctions between experiments which deal with brightness and those which deal with contrast become difficult. Contrasting elements are a most important factor in determining brightness. Nonetheless, there are other variables which influence the subjective response to illumination which merit our consideration. When stimulation is added binocularly, differences in contour and contrast properties may influence the sum. A vector sum of monocular brightnesses with weighting of the individual components on the basis of their contour and contrast has been demonstrated to be reasonably accurate (79, 80). Temporal factors as well as spatial factors may influence the judgment of brightness (266, 267), and sometimes spatial and temporal factors may interact in the determination of brightness relations of a visual stimulus presentation (264). This subject is considered in more detail in the chapter on Perception.

BINOCULAR VISION

The subject of binocular depth discrimination has been reviewed in detail recently (22). It seems appropriate to consider some work which relates to the sensitivity of binocular depth discrimination here, however. Depth discrimination limits are usually considered in terms of the minimum disparity angle which can be perceived. It is important to recognize that there is a maximum disparity angle which can afford discrimination of depth also (24). This maximum angle is greater for divergent than for convergent disparity. It is also larger in the periphery. The minimum disparity angle is also larger in the periphery (219). Sensitivity to depth differences based on binocular disparity is apparently greater, the greater the amount of visual detail in the scene viewed (169, 170). Restricting the total field without limiting visibility of the primary targets is associated with degraded stereoacuity as is viewing of the primary targets in a large ganzfeld. The wavelength distribution of illumination apparently has little or no influence on stereoacuity (72).

The discovery of neural units which seem to be specialized for the detection of disparity angles has been accompanied by development of interest in the binocular depth discrimination capability of those animals in which the neural units are studied. Stereoscopic vision has been investigated in the cat (94), and in the monkey (35, 133). It has been argued recently that the sensitivity to depth effects need not be dependent upon a precise comparison of geometric disparity of the two retinal images (25, 90). Rather, it is suggested, differential stimulation of channels which may be tuned for specific spatial frequencies could give rise to depth effects. It has been demonstrated that there are apparently distinct mechanisms for the discrimination of depth of objects beyond the point of fixation, in the region of fixation, and in front of the point of fixation (223). Certain individuals may lack one or more of these mechanisms with predictable results in their judgments of stereopatterns. It has been demonstrated that adaptation to a stereogram in which a given depth is represented may influence the perception of depth for subsequently viewed targets in a similar range of depth (29). Selective adaptation effects would certainly be altered for individuals lacking specialized detectors for depth behind fixation or in front of fixation. A theory of binocular vision has been presented by Sperling (260).

Electrophysiological correlates of binocular vision.—Measurements of visually evoked cortical potentials in man provide some support for the presence of disparity detectors in the human cortex (89). Presentation of grating patterns to both eyes results in a higher amplitude of evoked potential when there is a slight difference in spatial frequency between the two eyes with a corresponding disparity. Presumably this results in a greater level of stimulation of more cells than would the artificial situation where both eyes are stimulated with identical patterns. When the two eyes are stimulated dichoptically, one with a pattern and the other with a homogeneous field, response to the pattern stimulus tends to suppress response to the homogeneous field (52). The response to a relatively large pattern tends to be suppressed by the response to a small pattern and only when different patterns presented to the two eyes are of similar size is there a summation of their responses. Summation of responses appears to be more complete for scotopic levels of stimulation of the two eyes than for photopic levels. This is attributed to possibly greater amounts of convergence of cone signals from the two eyes on single cortical cells via interhemispheric pathways (51).

The cat continues to be a popular experimental animal for the electrophysiological study of binocular vision. Relative dominance of a given hemisphere by projections from the contralateral eye (33) and the relative variability of activity resulting from binocular as contrasted with monocular stimulation (62) have recently been investigated.

Convergence.—The possibility that the convergence angle may be a useful cue to depth has been reexamined and affirmative conclusions reached (201, 224). It would appear that approximately two-thirds of the population are able to use convergence as a cue to depth (224).

DEVELOPMENTAL FACTORS

An interesting and extremely fruitful line of investigation in recent years has been concerned with the effects of stimulus deprivation during the early developmental period of the organism. Occlusion of both eyes of an animal at birth results in a severe visual decrement if maintained up to some critical point, three months for the cat (68, 132). Occlusion of only one eye for the same length of time has results which are much more serious when measured in terms of the performance of that eye alone after it is uncovered. It is as if the eye which has not been covered has usurped many of the cortical connections which normally would be available to the other eye. Deficits appear to be primarily with respect to form discrimination. Variations on the basic deprivation experiment have been introduced in which selective aspects of the visual world are eliminated. Monkeys were raised in an environment illuminated by a brief flash of light presented at intervals sufficiently long, two seconds or more, that there was no continuous stimulation of the retina with light from moving objects or with light from a stationary object during movement of the head or eyes of the animal (202). These animals showed symptoms similar to those of dark-reared animals. It was suggested that the root of the problem might reside with the failure of the development of normal pupillary and accommodative responses. The ability of an animal to relate his movements appropriately to the visual stimulus he receives depends upon experience. If only one eye is permitted to see during active locomotion, the other eye being open during passive movement, visually guided movements can only be made with the eye which has had experience during active motion (125). Control does not transfer to the other eye. If cats are reared from birth with one eye viewing primarily horizontally oriented lines, the other primarily vertical, then receptive fields are found associated with cortical units in which the optimum orientation of a line element stimulus is vertical for the eye having had vertical experience and horizontal for the other eye. Responses to oblique orientations are not found (126, 127). The result has been confirmed in a slightly different kind of experiment (28).

The dependence of development on sensory stimulation is illustrated naturally in the Siamese cat which has aberrant visual projections to the cortex. These animals show binocularly activated cells if they are raised with both eyes occluded, whereas the binocular connections apparently drop out if they are raised with eyes open and there are associated abnormal stimulus effects (134). Cortical responses to binocular disparity are altered by raising kittens with prisms in front of their eyes (251). Apparently, even photopic and scotopic systems can be dissociated by selective stimulation of an animal during the developmental period (124).

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LITERATURE CITED

1. Allan, L. G., Kristofferson, A. B., Wiens, E. W. 1971. Duration discrimination of brief light flashes. *Percept. Psychophys.* 9:327–34
2. Alpern, M. 1971. Effect of a bright light flash on dark adaptation of human rods. *Nature* 230:394–96
3. Alpern, M., Rushton, W. A. H., Torii, S. 1970. The size of rod signals. *J. Physiol.* 206:193–208
4. Ibid. The attenuation of rod signals by backgrounds, 209–27
5. Ibid 1970. The attenuation of rod signals by bleachings. 207:449–61
6. Ibid. Signals from cones, 463–75
7. Andreassi, J. L., Mayzner, M. S., Beyda, D., Waxman, J. 1970. Sequential blanking: A U-shaped function. *Psychon. Sci.* 18:319–21
8. Andrews, D. P., Butcher, A. K. 1971. Rod threshold and patterned rhodopsin bleaching: The pigment epithelium as an adaptation pool. *Vision Res.* 11:761–85
9. Andrews, D. P., Hammond, P. 1970. Mesopic increment threshold spectral sensitivity of single optic tract fibres in the cat: cone-rod interaction. *J. Physiol.* 209:65–81
10. Ibid. Suprathreshold spectral properties of single optic tract fibres in cat, under mesopic adaptation: cone-rod interaction, 83–103
11. Armington, J. C., Corwin, T. R., Marsetta, R. 1971. Simultaneously recorded retinal and cortical responses to patterned stimuli. *J. Opt. Soc. Am.* 61:1514–21
12. Bagrash, F. M., Kerr, L. G., Thomas, J. P. 1971. Patterns of spatial integration in the detection of compound visual stimuli. *Vision Res.* 11:635–45
13. Baker, C. H., Monty, R. A. 1969. On the rate of stimulus occlusion during intermittent retinal stimulation. *Percept. Psychophys.* 6:61–64
14. Banderet, L. E., Payne, W. H. 1971. Visual masking following transient adaptation. *J. Opt. Soc. Am.* 61:955–58
15. Barlow, H. B., Fitzhugh, R., Kuffler, S. W. 1957. Dark adaptation, absolute threshold and Purkinje shift in single units of the cat's retina. *J. Physiol.* 137:327–37
16. Barlow, H. B., Levick, W. R. 1969. Changes in the maintained discharge with adaptation level in the cat retina. *J. Physiol.* 202:699–718
17. Battersby, W. S., Defabaugh, G. L. 1969. Neural limitations of visual excitability: aftereffects of subliminal stimulation. *Vision Res.* 9:757–68
18. Battersby, W. S., Schuckman, H. 1970. The time course of temporal summation. *Vision Res.* 10:263–73
19. Battersby, W. S., Sturr, J. F. 1970. Neural limitations of visual excitability, IX. Monocular and interocular changes of sensitivity during flicker stimulation. *J. Opt. Soc. Am.* 60:121–26
20. Beatty, J. 1969. Some further studies on the effect of grouping elements of a visual stimulus on the cortical evoked potential. *Percept. Psychophys.* 6:373–78
21. Bird, J. F., Mowbray, G. H. 1969. Visual transient phenomenon: its polarity and a paradox. *Science* 165:1, 588–89
22. Bishop, P. O., Henry, G. H. 1971. Spatial vision. *Ann. Rev. Psychol.* 22:119–60
23. Blackwell, H. R. 1970. Some aspects of the spatial organization of the human visual system. *Opt. Soc. Am. Meet. Philadelphia*
24. Blakemore, C. 1970. The range and scope of binocular depth discrimination in man. *J. Physiol.* 211:599–622
25. Blakemore, C. 1970. A new kind of stereoscopic vision. *Vision Res.* 10:1181–99
26. Blakemore, C., Campbell, F. W. 1969. On the existence of neurones in the human visual system selectively sensitive to the orientation and size of retinal images. *J. Physiol.* 203:237–60
27. Blakemore, C., Carpenter, R. H. S., Georgeson, M. A. 1970. Lateral inhibition between orientation detectors in the human visual system. *Nature* 228:1, 37–41
28. Blakemore, C., Cooper, G. F. 1970. Development of the brain depends on the visual environment. *Nature* 228:477–78
29. Blakemore, C., Julesz, B. 1971. Stereoscopic depth aftereffect produced without monocular cues. *Science* 171:286–88
30. Blakemore, C., Muncey, J. P. J., Ridley, R. M. 1971. Perceptual

fading of a stabilized cortical image. *Nature* 233:204–5

31. Blakemore, C., Nachmias, J. 1971. The orientation specificity of two visual aftereffects. *J. Physiol.* 213: 157–74
32. Blakemore, C., Nachmias, J., Sutton, P. 1970. The perceived spatial frequency shift: evidence for frequency-selective neurones in the human brain. *J. Physiol.* 210: 727–50
33. Blakemore, C., Pettigrew, J. D. 1970. Eye dominance in the visual cortex. *Nature* 225:1, 426–29
34. Blakemore, C., Sutton, P. 1969. Size adaptation: a new aftereffect. *Science:* 166:1, 245–47
35. Bough, E. W. 1970. Stereoscopic vision in the macaque monkey: a behavioral demonstration. *Nature* 225:1, 42–44
36. Bouma, H., Andriessen, J. J. 1970. Induced changes in the perceived orientation of line segments. *Vision Res.* 10:333–49
37. Bowen, M. E., Eriksen, C. W. 1969. The effects of area and perimeter on detection rates. *Percept. Psychophys.* 5:37–40
38. Boynton, R. M., Whitten, D. N. 1970. Visual adaptation in monkey cones: recordings of late receptor potentials. *Science* 170:2, 1423–26
39. Bridgeman, B. 1971. Metacontrast and lateral inhibition. *Psychol. Rev.* 78:528–39
40. Brindley, G. S. 1970. *Physiology of the Retina and Visual Pathway.* Baltimore: Williams & Wilkins. 315 pp.
41. Brown, J. L., Metz, J. W., Yohman, J. R. 1969. Test of scotopic suppression of the photopic process. *J. Opt. Soc. Am.* 12:1677–78
42. Budinger, T. F., Bichsel, H., Tobias, C. A. 1971. Visual phenomena noted by human subjects on exposure to neutrons of energies less than 25 million electron volts. *Science* 172:868–70
43. Campbell, F. W., Carpenter, R. H. S., Levinson, J. Z. 1969. Visibility of aperiodic patterns compared with that of sinusoidal gratings. *J. Physiol.* 204:283–98
44. Campbell, F. W., Cooper, G. F., Enroth-Cugell, C. 1969. The spatial selectivity of the visual cells of the cat. *J. Physiol.* 203:223–35
45. Campbell, F. W., Maffei, L. 1970. Electrophysiological evidence for the existence of orientation and size detectors in the human visual system. *J. Physiol.* 207:635–52
46. Campbell, F. W., Maffei, L. 1971. The tilt aftereffect: a fresh look. *Vision Res.* 11:833–40
47. Campbell, F. W., Nachmias, J., Jukes, J. 1970. Spatial-frequency discrimination in human vision. *J. Opt. Soc. Am.* 60:555–59
48. Cardu, B., Gilbert, M., Strobel, M. 1971. The influence of peripheral and central factors on the way stabilized images disappeared. *Vision Res.* 11:1337:43
49. Carter, B. E., Henning, G. B. 1971. The detection of gratings in narrow-band visual noise. *J. Physiol.* 219:355–65
50. Cavonius, C. R., Hilz, R. 1970. Visual performance after preadaptation to colored lights. *J. Exp. Psychol.* 83(3):359–65
51. Ciǵanek, L. 1970. Binocular addition of the visually evoked response with different stimulus intensities in man. *Vision Res.* 10:479–87
52. Ibid 1971. Binocular addition of the visual response evoked by dichoptic patterned stimuli. 11:1289–97
53. Cleland, B. G., Enroth-Cugell, C. 1970. Quantitative aspects of gain and latency in the cat retina. *J. Physiol.* 206:73–91
54. Coble, J. R., Ruston, W. A. H. 1971. Stiles-Crawford effect and the bleaching of cone pigments. *J. Physiol.* 217: 231–42
55. Corballis, M. C. 1970. On the asymmetry of the phase-difference function in binocular flicker. *Psychon. Sci.* 19(4):247–48
56. Cornsweet, T. N. 1970. *Visual Perception.* New York: Academic. 475 pp.
57. Corwin, T. R. 1971. Effect of masking by light on the apparent contrast of flashed gratings. *J. Opt. Soc. Am.* 61:1172–76
58. Cosgrove, M. P., Schmidt, M. J., Fulgham, D. D., Brown, D. R. 1971. The dependent variable in stabilized retinal image studies. *Vision Res.* 11:1183–87
59. Cox, S. I., Dember, W. N. 1970. Backward masking of visual targets with internal contours. *Psychon. Sci.* 19:255–56
60. Ibid 1971. Effects of target-field luminance, interstimulus interval, and target-mask separation on ex-

tent of visual backward masking. 22(2):79–80

61. Cox, S. I., Dember, W. N., Sherrick, M. F. 1969. Effect on backward masking of spatial separation between target and mask contours and of target size. *Psychon. Sci.* 17:205–6
62. Crawford, M. L. J., Cool, S. J. 1970. Binocular stimulation and response variability of striate cortex units in the cat. *Vision Res.* 10: 1145–53
63. Curtis, D. W. 1970. Magnitude estimations and category judgments of brightness and brightness intervals: A 2-stage interpretation. *J. Exp. Psychol.* 83(2):201–8
64. Daitch, J. M., Green, D. G. 1969. Contrast sensitivity of the human peripheral retina. *Vision Res.* 9: 947-52
65. Davidson, M., Whiteside, J. A. 1971. Human brightness perception near sharp contours. *J. Opt. Soc. Am.* 61:530–36
66. Daw, N. W., Pearlman, A. L. 1971. Rod saturation in the cat. *Vision Res.* 11:1361–64
67. DeValois, R. L., Pease, P. L. 1971. Contours and contrast: responses of monkey lateral geniculate nucleus cells to luminance and color figures. *Science* 171:694–96
68. Dews, P. B., Wiesel, T. N. 1970. Consequences of monocular deprivation on visual behaviour in kittens. *J. Physiol.* 206:437–55
69. Deppner, R., Armington, J. 1971. A behavioral measure of dark adaptation in the American red squirrel. *Psychon. Sci.* 24(1):43–45
70. Dobelle, W. H., Marks, W. B., MacNichol, E. F. Jr. 1969. Visual pigment density in single primate foveal cones. *Science* 166:2, 1508–10
71. Dow, B. M., Dubner, R. 1969. Visual receptive fields and responses to movement in an association area of cat cerebral cortex. *J. Neurophysiol.* 32:773–84
72. Dwyer, W. O., Lit, A. 1970. Effect of luminance-matched wavelength on depth discrimination at scotopic and photopic levels of target illumination. *J. Opt. Soc. Am.* 60: 127–31
73. Eason, R. G., Dudley, L. M. 1971. Effect of stimulus size and retinal locus of stimulation on visually evoked cortical responses and reaction in man. *Psychon. Sci.* 23(5): 345–47
74. Eason, R. G., White, C. T., Bartlett, N. 1970. Effects of checkerboard pattern stimulation on evoked cortical responses in relation to check size and visual field. *Psychon. Sci.* 21:113–15
75. Efron, R. 1970. The relationship between the duration of a stimulus and the duration of a perception. *Neuropsychologia* 8:37–55
76. Ibid. The minimum duration of a perception, 57–63
77. Efron, R. 1970. Effect of stimulus duration on perceptual onset and offset latencies. *Percept. Psychophys.* 8:231–34
78. Ellis, D., Dember, W. N. 1971. Backward masking of visual targets with internal contours: a replication. *Psychon. Sci.* 22(2):91–92
79. Engel, G. R. 1969. The autocorrelation function and binocular brightness mixing. *Vision Res.* 9:1111–30
80. Engel, G. R. 1970. Tests of a model of binocular brightness. *Can. J. Psychol.* 24:335–52
81. Enoch, J. M., Sunga, R. N. 1969. Development of quantitative perimetric tests. *Doc. Ophthalmol.* 26:215–29
82. Fagot, R. F., Stewart, M. R. 1969. Individual half-judgment brightness functions. *Percept. Psychophys.* 5:165–70
83. Fazio, G. G., Jelley, J. V., Charman, W. N. 1970. Generation of Cherenkov light flashes by cosmic radiation within the eyes of the Apollo astronauts. *Nature* 228: 260–64
84. Festinger, L., Allyn, M. R., White, C. W. 1971. The perception of color with achromatic stimulation. *Vision Res.* 11:591–612
85. Festinger, L., Coren, S., Rivers, G. 1970. The effect of attention on brightness contrast and assimilation. *Am. J. Psychol.* 83:189–207
86. Fidell, L. S. 1970 Orientation specificity in chromatic adaptation of human "edge-detectors" *Percept. Psychophys.* 7:235–37
87. Findlay, J. M. 1969. A spatial integration effect in visual acuity. *Vision Res.* 9:157–66
88. Fiorentini, A., Maffei, L. 1970. Transfer characteristics of excitation and inhibition in the human visual system. *J. Neurophysiol.* 33:285–92

89. Fiorentini, A., Maffei, L. 1970. Electrophysiological evidence for binocular disparity detectors in human visual system. *Science* 169:208–9
90. Fiorentini, A., Maffei, L. 1971. Binocular depth perception without geometrical cues. *Vision Res.* 11:1299–1305
91. Flaherty, T. B., Matteson, H. H. 1971. Comparison of two measures of metacontrast. *J. Opt. Soc. Am.* 61:828–30
92. Flock, H. R. 1970. Jameson and Hurvich's theory of brightness contrast. *Percept. Psychophys.* 8: 118–24
93. Flock, H. R., Noguchi, K. 1970. An experimental test of Jameson and Hurvich's theory of brightness contrast. *Percept. Psychophys.* 8: 129–36
94. Fox, R., Blake, R. R. 1971. Stereoscopic vision in the cat. *Nature* 233:55–56
95. Fry, G. A. 1969. Visibility of sinewave gratings. *J. Opt. Soc. Am.* 59:610–17
96. Galbraith, G. C., Heath, R. G. 1970. Backward visual masking during direct brain stimulation in man. *Vision Res.* 10:911–15
97. Gersuni, G. V. 1971. *Sensory Processes at the Neuronal and Behavioral Levels.* New York: Academic. 333 pp.
98. Geissmann, H.-G., Lutze, B. 1971. Die β-Inflexion in der Dunkeladaptationskurve. *Vision Res.* 11:343–50
99. Giger, H., Fankhauser, F. 1969. Die linearen Modelle des Helligkeitssehens. *Vision Res.* 9:785–801
100. Gilinsky, A. S., Doherty, R. S. 1969. Interocular transfer or orientational effects. *Science* 164:454–55
101. Gilinsky, A. S., Mayo, T. H. 1971. Inhibitory effects of orientational adaptation. *J. Opt. Soc. Am.* 61: 1710–14
102. Glantz, R. M. 1971. Toward a general theory of visual adaptation. *Doc. Ophthalmol.* 30:245–58
103. Graham, N., Nachmias, J. 1971. Detection of grating patterns containing two spatial frequencies: a comparison of single-channel and multiple-channel models. *Vision Res.* 11:251–59
104. Green, D. G. 1970. Testing the vision of cataract patients by means of laser-generated interference fringes. *Science* 168:1240–42
105. Green, D. G. 1970. Regional variations in the visual acuity for interference fringes on the retina. *J. Physiol.* 207:351–56
106. Grossberg, M. 1970. Frequencies and latencies in detecting two-flash stimuli. *Percept. Psychophys.* 7: 377–80
107. Guth, S. L., Donley, N. J., Marrocco, R. T. 1969. On luminance additivity and related topics. *Vision Res.* 9:537–75
108. Haber, R. N., Standing, L. G. 1970. Direct estimates of the apparent duration of a flash. *Can. J. Psychol.* 24:216–29
109. Hallett, P. E. 1969. Rod increment thresholds on steady and flashed backgrounds. *J. Physiol.* 202:355–77
110. Ibid. Impulse function for human rod vision, 379–402
111. Ibid. The variations in visual threshold measurement, 403–19
112. Ibid 1971. Disturbances of rod threshold forced by briefly exposed luminous lines, edges, disks and annuli. 215:449–76
113. Ibid. Rapid changes and hysteresis in spatial integration for human rod vision, 533–47
114. Halliday, A. M., Michael, W. F. 1970. Changes in pattern-evoked responses in man associated with the vertical and horizontal meridians of the visual field. *J. Physiol.* 208:499–513
115. Hammond, P. 1971. Chromatic sensitivity and spatial organization of cat visual cortical cells: cone-rod interaction. *J. Physiol.* 213:475–94
116. Hammond, P., James, C. R. 1971. The Purkinje shift in cat: extent of the mesopic range. *J. Physiol.* 216: 99–109
117. Hansteen, R. W. 1971. Visual latency as a function of stimulus onset, offset, and background luminance. *J. Opt. Soc. Am.* 61:1190–95
118. Harter, M. R. 1970. Evoked cortical responses to checkerboard patterns: effect of check-size as a function of retinal eccentricity. *Vision Res.* 10:1365–76
119. Ibid 1971. Visually evoked cortical responses to the on-and off-set of patterned light in humans. 11: 685–95
120. Harter, M. R., Suitt, C. D. 1970. Visually evoked cortical responses and pattern vision in the infant: a

longitudinal study. *Psychon. Sci.* 18:235–37

121. Harter, M. R., White, C. T. 1970. Evoked cortical responses to checkerboard patterns: effect of check-size as a function of visual acuity. *Electroencephalogr. Clin. Neurophysiol.* 28:48–54
122. Harvey, L. O. Jr. 1970. A critical flicker frequency as a function of viewing distance, stimulus size and luminance. *Vision Res.* 10:55–63
123. Harvey, L. O. Jr. 1970. Flicker sensitivity and apparent brightness as a function of surround luminance. *J. Opt. Soc. Am.* 60:860–64
124. Hein, A., Diamond, R. M. 1971. Independence of the cat's scotopic and photopic systems in acquiring control of visually guided behavior. *J. Comp. Physiol. Psychol.* 76:31–38
125. Hein, A., Held, R., Gower, E. 1970. Development and segmentation of visually controlled movement by selective exposure during rearing. *J. Comp. Physiol. Psychol.* 73:181–87
126. Hirsch, H. V. B., Spinelli, D. N. 1971. Modification of the distribution of receptive field orientation in cats by selective visual exposure during development. *Exp. Brain Res.* 13:509–27
127. Hirsch, H. V. B., Spinelli, D. N. 1970. Visual experience modifies distribution of horizontally and vertically oriented receptive fields in cats. *Science* 168:869–71
128. Hollins, M. 1971. Brightness contrast at low levels. *Vision Res.* 11:1449–72
129. Horn, G., Hill, R. M. 1969. Modifications of receptive fields of cells in the visual cortex occurring spontaneously and associated with body tilt. *Nature* 22:186–88
130. Hough, E. A., Ruddock, K. H. 1969. The Purkinje shift. *Vision Res.* 9:313–15
131. Ibid. The parafoveal visual response of a tritanope and an interpretation of the V_λ sensitivity functions of mesopic vision, 935–46
132. Hubel, D. H., Wiesel, T. N. 1970. The period of susceptibility to the physiological effects of unilateral eye closure in kittens. *J. Physiol.* 206:419–36
133. Hubel, D. H., Wiesel, T. N. 1970. Stereoscopic vision in macaque monkey. *Nature* 225:1, 41–42
134. Hubel, D. H., Wiesel, T. N. 1971. Aberrant visual projections in the Siamese cat. *J. Physiol.* 218:33–62
135. Ikeda, M. 1971. Flicker heterochromatic threshold-reduction factor with two or more flickering fields. *J. Opt. Soc. Am.* 61:261–66
136. Jacobs, G. H. 1969. Receptive fields in visual systems. *Brain Res.* 14:553–73
137. Jacobs, G. H., Yolton, R. L. 1971. Spectral sensitivity of non-opponent cells in the lateral geniculate nucleus. *Vision Res.* 11:1179–82
138. Jameson, D., Hurvich, L. M. 1970. Improvable, yes; insoluble, no: a reply to Flock. *Percept. Psychophys.* 8:125–28
139. Jeffreys, D. A. 1971. Cortical source locations of pattern-related visual evoked potentials recorded from the human scalp. *Nature* 229:502–4
140. Kaiser, P. K. 1971. Minimally distinct border as a preferred psychophysical criterion in visual heterochromatic photometry. *J. Opt. Soc. Am.* 61:966–71
141. Kaiser, P. K., Green, T. S. 1971. Brightness difference and its relation to the distinctness of a border. *J. Opt. Soc. Am.* 61:962–65
142. Karrer, R. 1969. Visual beats: differential brightness of the stimuli and estimation of brightness. *Vision Res.* 9:429–33
143. Karrer, R., Clausen, J. 1969. Visual beats: preliminary observations of perceived rate as a function of retinal locus stimulated. *Percept. Psychophys.* 5:163–64
144. Keesey, U. T. 1969. Visibility of a stabilized target as a function of frequency and amplitude of luminance variation. *J. Opt. Soc. Am.* 59:604–10
145. Ibid 1970. Variables determining flicker sensitivity in small fields. 60:390–98
146. Keesey, U. T. 1971. Comparison of human visual cortical potentials evoked by stabilized and unstabilized targets. *Vision Res.* 11:657–70
147. Kelly, D. H. 1969. Flickering patterns and lateral inhibition. *J. Opt. Soc. Am.* 59:1361–70
148. Ibid. Diffusion model of linear flicker responses, 1665–70
149. Ibid 1970. Effects of sharp edges on the visibility of sinusoidal gratings. 60:98–103
150. Ibid 1971. Theory of flicker and transient responses, I. Uniform fields. 61:537–46

151. Ibid. Theory of flicker and transient responses, II. Counterphase gratings, 632–40
152. Kerr, J. L. 1971. Visual resolution in the periphery. *Percept. Psychophys.* 9:375–78
153. Kintz, R. T., Boynton, R. M. 1969. Temporal summation during backward visual masking. *J. Opt. Soc. Am.* 59:212–16
154. Kishto, B. N., Saunders, R. 1970. Variation of the visual threshold with retinal location. *Vision Res.* 10:745–67
155. König, H. 1970. Die Blendwirkung monochromatischen Lichtes auf des menschliche Auge. *Vision Res.* 10:875–85
156. Kornfeld, G. H., Lawson, W. R. 1971. Visual-perception models. *J. Opt. Soc. Am.* 61:811–20
157. Kowaliski, P. 1969. Equivalent luminances of colors. *J. Opt. Soc. Am.* 59:125–30
158. Krantz, D. H. 1969. Threshold theories of signal detection. *Psychol. Rev.* 76(3):308–24
159. Kulikowski, J. J. 1971. Some stimulus parameters affecting spatial and temporal resolution of human vision. *Vision Res.* 11:83–93
160. Ibid. Effect of eye movements on the contrast sensitivity of spatio-temporal patterns, 261–73
161. Lakowski, R., Aspinall, P. A. 1969. Static perimetry in young children. *Vision Res.* 9:305–12
162. LaMotte, R. H., Brown, J. L. 1970. Dark adaptation and spectral sensitivity in the cat. *Vision Res.* 10: 703–16
163. Land, E. H., McCann, J. J. 1971. Lightness and retinex theory. *J. Opt. Soc. Am.* 61:1–11
164. Lansford, T. G., Baker, H. D. 1969. Dark adaptation: an interocular light-adaptation effect. *Science* 164:2, 1307–9
165. Lavergne, G., deCorte, M-T. 1970. La détermination de l'exposant de sommation par la mesure de la fréquence critique de fusion. *Vision Res.* 10:351–58
166. Leibovic, K. N. 1971. On the retinal basis of visual adaptation. *Kybernetik* 3:96–111
167. Lindauer, M. S., Baust, R. F. 1970. Instructions and knowledge of the situation in brightness perception. *Am. J. Psychol.* 83:130–31
168. Lockhart, J. M. 1971. Ambient temperature and the flicker-fusion threshold. *J. Exp. Psychol.* 87(3): 314–19
169. Luria, S. M. 1969. Stereoscopic and resolution acuity and various fields of view. *Science* 164:452–53
170. Luria, S. M. 1971. Effect of limited peripheral cues on stereoacuity. *Psychon. Sci.* 24(4):195–96
171. MacKinnon, G. E., Forde, J., Piggins, D. J. 1969. Stabilized images, steadily fixated figures, and prolonged afterimages. *Can. J. Psychol.* 23:184–95
172. Maffei, L., Campbell, F. W. 1970. Electrophysiological localization of the vertical and horizontal coordinates in the human visual system. *Science* 167:386–87
173. Maffei, L., Cervetto, L., Fiorentini, A. 1970. Transfer characteristics of excitation and inhibition in cat retinal ganglion cells. *J. Neurophysiol.* 33:276–84
174. Maffei, L., Fiorentini, A., Cervetto, L. 1971. Homeostasis in retinal receptive fields. *J. Neurophysiol.* 34:579–87
175. Marg, E., Adams, J. E. 1970. Evidence for a neurological zoom system in vision from angular changes in some receptive fields of single neurons with changes in fixation distance in the human visual cortex. *Experientia* 26:270–72
176. Markoff, J. I., Sturr, J. F. 1971. Spatial and luminance determinants of the increment threshold under monoptic and dichoptic viewing. *J. Opt. Soc. Am.* 61:1530–31
177. Marks, L. E. 1970. Apparent depth of modulation as a function of frequency and amplitude of temporal modulations of luminance. *J. Opt. Soc. Am.* 60:970–77
178. Matteson, H. H. 1969. Effects of surround size and luminance on metacontrast. *J. Opt. Soc. Am.* 59: 1461–68
179. Ibid 1970. Effects of surround luminance on perceptual latency. 60: 1125–31
180. Ibid 1971. Effects of surround luminance on perceptual latency in the fovea. 61:1169–72
181. Matthews, M. L. 1971. Spatial and temporal factors in masking by edges and disks. *Percept. Psychophys.* 9:15–22
182. May, J. G., Siegfried, J. B. 1970. Spectral sensitivity of the human VER obtained with an alternating

barred pattern. *Vision Res.* 10: 1399–1410

183. Mayzner, M. S. 1970. The disinhibited effect in sequential blanking. *Psychon. Sci.* 20(4):218–19
184. Mayzner, M. S., Tresselt, M. E. 1969. Sequential blanking: a function of geometric analyzers in the human visual system. *Psychon. Sci.* 17:77–78
185. McClure, G., Smith, K. 1969. Simultaneous brightness contrast as a function of repeated trials. *Psychon. Sci.* 16:314–15
186. McCollough, C. 1965. Color adaptation of edge detectors in the human visual system. *Science* 148: 1115–16
187. McKee, S. P., Westheimer, G. 1970. Specificity of cone mechanisms in lateral interaction. *J. Physiol.* 206:117–28
188. Menzer, G. W., Thurmond, J. B. 1970. Form identification in peripheral vision. *Percept. Psychophys.* 8:205–9
189. Methling, D. 1970. Sehschärfe bei Augenfolgebewegungen in Abhängigkeit von der Gesichtsfeldleuchtdichte. *Vision Res.* 10:535–41
190. Miller, H. L. 1969. Effect of auditory stimulation on critical flicker fusion frequency. *J. Exp. Psychol.* 81(2):365–69
191. Miller, R. F., Dowling, J. E. 1970. Intracellular responses of the Müller (glial) cells of mudpuppy retina: their relation to b-wave of the electroretinogram. *J. Neurophysiol.* 33:232–41
192. Millodot, M., Riggs, L. A. 1970. Refraction determined electrophysiologically. *Arch. Ophthalmol.* 84: 272–78
193. Moody, D. B. 1969. Equal brightness functions for supra-threshold stimuli in the pigmented rat: a behavioral determination. *Vision Res.* 9:1381–89
194. Muir, D., Over, R. 1970. Tilt aftereffects in central and peripheral vision. *J. Exp. Psychol.* 85(2):165–70
195. Murch, G. M. 1969. Size judgments of McCollough afterimages. *J. Exp. Psychol.* 81(1):44–48
196. Nachmias, J., Kocher, E. C. 1970. Visual detection and discrimination of luminance increments. *J. Opt. Soc. Am.* 60:382–89
197. Nakayama, K. 1971. Local adaptation in cat LGN cells: evidence for a surround antagonism. *Vision Res.* 11:501–9
198. Nilsson, T. H., Nelson, T. N. 1971. Hue shifts produced by intermittent stimulation. *Vision Res.* 11: 697–712
199. Novak, S. 1969. Comparison of increment and decrement thresholds near a bright-dark boundary. *J. Opt. Soc. Am.* 59:1383–84
200. Ono, H., Komoda, M., Mueller, E. R. 1971. Intermittent stimulation of binocular disparate colors and central color fusion. *Percept. Psychophys.* 9:343–47
201. Ono, H., Mitson, L., Seabrook, K. 1971. Change in convergence and retinal disparities as an explanation for the wallpaper phenomenon. *J. Exp. Psychol.* 91(1):1–10
202. Orbach, J., Miller, M. H. 1969. Visual performance in infra-human primates reared in an intermittently illuminated room. *Vision Res.* 9:713–16
203. Owen, D. H., Chalfant, C. 1970. Central integration effects with stabilized afterimages. *Percept. Psychophys.* 7:284–86
204. Padgham, C. A. 1971. The direct estimation of the luminosity of coloured light sources. *Vision Res.* 11:577–90
205. Padmos, P., van Norren, D. 1971. Cone spectral sensitivity and chromatic adaptation as revealed by human flicker-electroretinography. *Vision Res.* 11:27–42
206. Palmer, D. 1970. Luminance matching functions. *Vision Res.* 10:563–73
207. Pantle, A. 1970. Adaptation to pattern spatial frequency: effects on visual movement sensitivity in humans. *J. Opt. Soc. Am.* 60:1120–24
208. Pantle, A. 1971. Flicker adaptation—I. Effect on visual sensitivity to temporal fluctuation of light intensity. *Vision Res.* 11:943–52
209. Pantle, A., Sekuler, R. 1969. Contrast response of human visual mechanisms sensitive to orientation and direction of motion. *Vision Res.* 9:397–406
210. Parlee, M. B. 1969. Visual backward masking of a single line by a single line. *Vision Res.* 9:199–205
211. Payne, W. H. 1970. Foveal border-contrast. *Vision Res.* 10:513–18
212. Payne, W. H., Anderson, D. E. 1969. Border-visibility investigation of

the Hermann grid. *J. Opt. Soc. Am.* 59:229–31

213. Payne, W. H., Anderson, D. E. 1969. Border-contrast: corner brightening effects. *Vision Res.* 9:1309–13
214. Perry, N. W., Childers, D. G. 1969. *The Human Visual Evoked Response: Method and Theory.* Springfield, Ill.: Thomas. 187 pp.
215. Pierce, J. R., Levene, J. R., Eds. 1971. *Visual Science.* Bloomington: Indiana Univ. Press. 408 pp.
216. Pollehn, H., Roehrig, H. 1970. Effect of noise on the modulation transfer function of the visual channel. *J. Opt. Soc. Am.* 60:842–48
217. Prestrude, A. M., Baker, H. D. 1971. Light adaptation and visual latency. *Vision Res.* 11:363–69
218. Rashbass, C. 1970. The visibility of transient changes of luminance. *J. Physiol.* 210:165–86
219. Rawlings, S. C., Shipley, T. 1969. Stereoscopic acuity and horizontal angular distance from fixation. *J. Opt. Soc. Am.* 59:991–93
220. Regan, D. 1970. Objective method of measuring the relative spectral-luminosity curve in man. *J. Opt. Soc. Am.* 60:856–59
221. Regan, D., Richards, W. 1971. Independence of evoked potentials and apparent size. *Vision Res.* 11:679–84
222. Remole, A. 1971. Luminance thresholds for subjective patterns in a flickering field: effect of wavelength. *J. Opt. Soc. Am.* 61:1164–68
223. Richards, W. 1971. Anomalous stereoscopic depth perception. *J. Opt. Soc. Am.* 61:410–14
224. Richards, W., Miller, J. F. Jr. 1969. Convergence as a clue to depth. *Percept. Psychophys.* 5:317–20
225. Riggs, L. A. 1969. Progress in the recording of human retinal and occipital potentials. *J. Opt. Soc. Am.* 59:1558–66
226. Rinalducci, E. J., Higgins, K. E., Cramer, J. A. 1970. Nonequivalence of backgrounds during photopic dark adaptation. *J. Opt. Soc. Am.* 60:1518–24
227. Ripps, H., Vaughn, H. G. Jr. 1969. The spectral sensitivity of evoked potentials from the retina and cortex of nocturnal and diurnal monkeys. *Vision Res.* 9:895–907
228. Robinson, D. N. 1970. Critical flicker-fusion of solid and annular stimuli. *Science* 167:207–8
229. Ronchi, V. 1970. *The Nature of Light: an Historical Survey.* Cambridge: Harvard Univ. Press. 228 pp.
230. Ronchi, L. 1970. Time course of perception probability under prolonged testing at various eccentricities. *Vision Res.* 10:605–7
231. Ronchi, L. 1971. Absolute threshold before and after correction of oblique-ray astigmatism. *J. Opt. Soc. Am.* 61:1705–9
232. Ronchi, L., Novakova, O. 1971. Luminance-time relation at various eccentricities: individual differences. *J. Opt. Soc. Am.* 61:115–18
233. Rosenberger, P. B., Ernest, J. T. 1971. Behavioral assessment of absolute visual thresholds in the albino rat. *Vision Res.* 11:199–207
234. Rubin, M. L., Walls, G. L. 1969. *Fundamentals of Visual Science.* Springfield: Thomas. 435 pp.
235. Ruddock, K. H. 1969. Cone vision under small field conditions. *Opt. Acta* 16:391–98
236. Rushton, W. A. H. 1965. Bleached rhodopsin and visual adaptation. *J. Physiol.* 181:645–55
237. Rushton, W. A. H., Fulton, A. B., Baker, H. D. 1969. Dark adaptation and the rate of pigment regeneration. *Vision Res.* 9:1473–79
238. Sachs, M. B., Nachmias, J., Robson, J. G. 1971. Spatial-frequency channels in human vision. *J. Opt. Soc. Am.* 61:1176–86
239. Sakman, B., Creutzfeldt, O. D., Scheich, H. 1969. An experimental comparison between the ganglion cell receptive field and the receptive field of the adaptation pool in the cat retina. *Pfluegers Arch.* 307:133–37
240. Salinger, W. L., Lindsley, D. B. 1971. The suppression-recovery effect and visual adaptation in the cat. *Vision Res.* 11:1435–44
241. Schiller, P. H. 1969. Behavioral and electrophysiological studies of visual masking. *Information Processing in the Nervous System*, ed. K. N. Leibovic, 141–65. Berlin/Göttingen.Heidelberg: Springer-Verlag
242. Schiller, P. H., Greenfield, A. 1969. Visual masking and the recovery phenomenon. *Percept. Psychophys.* 6:182–84
243. Schoenberg, K. M., Katz, M., Mayzner, M. S. 1970. The shape of inhibitory fields in the human visual

systems. *Percept. Psychophys.* 7: 357–59

244. Schurman, D. L., Colegate, R. L. 1970. Dark intervals as stimulus events and their effect on visual masking and time-intensity reciprocity. *J. Exp. Psychol.* 85(2): 278–87
245. Schurman, D. L., Eriksen, C. W. 1969. Summation and interaction of successive masking stimuli in visual perception. *Am. J. Psychol.* 82:320–32
246. Schusterman, R. J., Balliet, R. F. 1970. Conditioned vocalizations as a technique for determining visual acuity thresholds in sea lions. *Science* 169:498–501
247. Semmelroth, C. C. 1970. Prediction of lightness and brightness on different backgrounds. *J. Opt. Soc. Am.* 60:1685–89
248. Sherrick, M. F., Dember, W. N. 1970. Completeness and spatial distribution of mask contours as factors in visual backward masking. *J. Exp. Psychol.* 84(1):179–80
249. Sherrick, M. F., Dember, W. N. 1970. Visual backward masking and the area-detection relation. *Psychon. Sci.* 19(2):127–28
250. Schickman, G. M. 1970. Visual masking by low-frequency sinusoidally modulated light. *J. Opt. Soc. Am.* 60:107–17
251. Shlaer, R. 1971. Shift in binocular disparity causes compensatory change in the cortical structure of kittens. *Science* 173:638–41
252. Siegfried, J. B. 1971. Spectral sensitivity of human visual evoked cortical potentials: a new method and a comparison with psychophysical data. *Vision Res.* 11:405–17
253. Smith, R. A. 1970. Adaptation of visual contrast sensitivity to specific temporal frequencies. *Vision Res.* 10:275–79
254. Smith, R. A. 1971. Studies of temporal frequency adaptation in visual contrast sensitivity. *J. Physiol.* 216:531–52
255. Smith, R. A., Richards, W. 1969. Propagation velocity of lateral interaction in the human visual system. *J. Opt. Soc. Am.* 59:1469–72
256. Smith, V. C. 1969. Scotopic and photopic functions for visual band movement. *Vision Res.* 9:293–304
257. Ibid. Temporal and spatial interactions involved in the band movement phenomenon, 665–76
258. Sokol, S. 1970. Cortical and retinal spectral sensitivity of the hooded rat. *Vision Res.* 10:253–62
259. Sperling, G. 1970. Model of visual adaptation and contrast detection. *Percept. Psychophys.* 8:143–57
260. Sperling, G. 1970. Binocular vision: a physical and a neural theory. *Am. J. Psychol.* 83:461–534
261. Sperling, G. 1971. Information retrieval from two rapidly consecutive stimuli: a new analysis. *Percept. Psychophys.* 9:89–91
262. Sperling, H. C., Harwerth, R. S. 1971. Red-green cone interactions in the increment-threshold spectral sensitivity of primates. *Science* 171:180–84
263. Spillmann, L. 1971. Foveal perceptive fields in the human visual system measured with simultaneous contrast in grids and bars. *Pfluegers Arch.* 326:281–99
264. Stanley, G., Finlay, D. C., Bartlett, W. K. 1971. Regions of brightness and darkness in the sequential presentation of partially overlapping straight lines. *J. Exp. Psychol.* 88:314–18
265. Stecher, S. 1971. Retroactive masking without spatial transients. *J. Exp. Psychol.* 91(1):34–42
266. Stecher, S., Sandberg, M. 1970. The relationship between binocular brightness matches and luminance difference discriminability of successively presented light flashes. *Percept. Psychophys.* 7:86–90
267. Stecher, S., Sandberg, M., Minsky, P. J. 1970. Successive luminance difference thresholds and brightness as a function of the interstimulus interval and durations of successive flashes. *Percept. Psychophys.* 7:79–85
268. Steinberg, R. H. 1969. Rod and cone contributions to *S*-potentials from the cat retina. *Vision Res.* 9:1319–29
269. Ibid. Rod-cone interaction in *S*-potentials from the cat retina, 1331–44
270. Stewart, D. L., Chow, K. L., Masland, R. H. 1971. Receptive-field characteristics of lateral geniculate neurons in the rabbit. *J. Neurophysiol.* 34:139–47
271. Sticht, T. G. 1969. Effects of intensity and duration on the latency of response to brief light and dark

stimuli. *J. Exp. Psychol.* 80(3):419–22

272. Stratton, L. O., Edwards, S. 1971. Preference and sensory factors in brightness discrimination learning of posterior neodecorticated albino rats. *Psychon. Sci.* 24(6):9–10

273. Stromeyer, C. F. 1969. Further studies of the McCollough effect. *Percept. Psychophys.* 6:105–10

274. Stromeyer, C. F., Mansfield, R. J. W. 1970. Colored aftereffects produced with moving edges. *Percept. Psychophys.* 7:108–14

275. Tees, R. C. 1971. Luminance and luminous flux discrimination in rats after early visual deprivation. *J. Comp. Physiol. Psychol.* 74:292–97

276. Teller, D. Y. 1971. Sensitization by annular surrounds: temporal (masking) properties. *Vision Res.* 11:1325–35

277. Teller, D. Y., Gestrin, P. J. 1969. Sensitization by annular surrounds: sensitization and dark adaptation. *Vision Res.* 9:1481–89

278. Teller, D. Y., Lindsey, B. 1970. Sensitization by annular surrounds: individual differences. *Vision Res.* 10:1045–55

279. Teller, D. Y., Matter, C. F., Phillips, W. D. 1970. Sensitization by annular surrounds: spatial summation properties. *Vision Res.* 10:549–61

280. Teller, D. Y., Matter, C. F., Phillips, W. D., Alexander, K. 1971. Sensitization by annular surrounds: sensitization and masking. *Vision Res.* 11:1445–58

281. Thomas, J. P. 1970. Model of the function of receptive fields in human vision. *Psychol. Rev.* 77:121–34

282. Thomas, J. P., Bagrash, F. M., Kerr, L. G. 1969. Selective stimulation of two form-sensitive mechanisms. *Vision Res.* 9:625–27

283. Thomas, J. P., Kerr, L. G. 1969. Effect of ramp-like contours upon perceived size and detection threshold. *Percept. Psychophys.* 5:381–84

284. Thomas, J. P., Kerr, L. G. 1971. Evidence of role of size-tuned mechanisms in increment threshold task. *Vision Res.* 11:647–55

285. Thomas, J. P., Padilla, G. J., Rourke, D. L. 1969. Spatial interactions in identification and detection of compound visual stimuli. *Vision Res.* 9:283–92

286. Thorn, F. 1970. Detection of luminance differences by the cat. *J. Comp. Physiol. Psychol.* 70:326–34

287. Tobias, C. A., Budinger, T. F., Lyman, J. T. 1971. Radiation-induced light flashes observed by human subjects in fast neutron, X-ray and positive pion beams. *Nature* 230:596–98

288. Treisman, M., Leshowitz, B. 1969. The effects of duration, area, and background intensity on the visual intensity difference threshold given by the forced-choice procedure: derivations from a statistical decision model for sensory discrimination. *Percept. Psychophys.* 6:281–96

289. Uetsuki, T., Ikeda, M. 1970. Study of temporal visual response by the summation index. *J. Opt. Soc. Am.* 60:377–81

290. Uttal, W. R. 1970. Violations of visual simultaneity. *Percept. Psychophys.* 7:133–42

291. Uttal, W. R., Hieronymus, R. 1970. Spatio-temporal effects in visual gap detection. *Percept. Psychophys.* 8:321–26

292. van der Horst, G. J. C., Miris, W. 1969. Hue shift and brightness enhancement of flickering light. *Vision Res.* 9:953–63

293. van Norren, D. 1971. Macaque photopic spectral sensitivity. *Vision Res.* 11:1175–77

294. Verriest, G., Haznedaroglu, G. 1969. Mesure subjective et objective de l'adaptation à l'obscurité à l'aide du même appareillage et application de celui-ci à l'étude comparative de l'adaptation depuis l'enfance jusquà l'âge adulte. *Vision Res.* 9:769–83

295. Verriest, G., Ortiz-Olmedo, A. 1969. Étude comparative du seuil différentiel de luminance et de l'exposant de sommation spatiale pour des objets pleins et pour des objets annulaires de mêmes surfaces. *Vision Res.* 9:267–92

296. Wales, R., Fox, R. 1970. Increment detection thresholds during binocular rivalry suppression. *Percept. Psychophys.* 8:90–94

297. Walters, J. W. 1971. Scotopic vision at photopic levels. *Vision Res.* 11:787–98

298. Wasserman, G. S. 1969. Hetero-

chromatic additivity failure. *Psychol. Rev.* 76:221–23

299. Wasserman, G. S., Gillman, C. B. 1970. Subadditivity and superadditivity of heterochromatic lights. *Psychol. Rev.* 77:338–42
300. Wasserman, G. S., Patton, D. G. 1970. *Limulus* visual threshold obtained from light-elicited unconditioned tail movements. *J. Comp. Physiol. Psychol.* 73:111–16
301. Wässle, H., Heinrich, F. 1970. Untersuchungen zum Helligkeitskontrast. *Vision Res.* 10:361–73
302. Webster, J. G. 1969. Critical duration for the pupillary light reflex. *J. Opt. Soc. Am.* 59:1473–78
303. Weisstein, N., Jurkens, T., Onderisin, T. 1970. Effect of forced-choice vs. magnitude-estimation measures on the waveform of metacontrast functions. *J. Opt. Soc. Am.* 60:978–80
304. Werblin, F. S. 1970. Response of retinal cells to moving spots: intracellular recording in *Necturus maculosus. J. Neurophysiol.* 33:342–50
305. Westheimer, G. 1965. Spatial interaction in the human retina during scotopic vision. *J. Physiol.* 181:881–94
306. Ibid 1967. Spatial interaction in human cone vision. 190:139–54
307. Ibid 1968. Bleached rhodopsin and retinal interaction. 195:97–105
308. Ibid 1970. Rod-cone independence for sensitizing interaction in the human retina. 206:109–16
309. Westheimer, G., Wiley, R. W. 1970. Distance effects in human scotopic retinal interaction. *J. Physiol.* 206:129–43
310. Whiteside, J. A., Davidson, M. L. 1971. Symmetrical appearance of bright and dark Mach bands from an exponential illumination gradient. *J. Opt. Soc. Am.* 61:958–61
311. Whittle, P., Chellands, P. D. C. 1969. The effect of background luminance on the brightness of flashes. *Vision Res.* 9:1095–1110
312. Wilson, J. A., Anstis, S. M. 1969. Visual delay as a function of luminance. *Am. J. Psychol.* 82:350–58
313. Wilson, M. E. 1970. Invariant features of spatial summation with changing locus in the visual field. *J. Physiol.* 207:611–22
314. Woll, S., Eriksen, C. W., Hake, H. W. 1970. A forced-choice study of edge detectors in the human visual system. *Percept. Psychophys.* 9:247–52
315. Wurtz, R. H. 1969. Visual receptive fields of striate cortex neurons in awake monkeys. *J. Neurophysiol.* 32:727–42
316. Zacks, J. L. 1970. Temporal summation phenomena at threshold: their relation to visual mechanisms. *Science* 170:197–99

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THE SENSE OF SMELL

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In contrast to earlier reviews, including the most recent one by Tucker & Smith (134), the present chapter will emphasize experiments done with human subjects. It will exclude neurophysiological and animal experiments usually emphasized in such reviews and in textbooks of psychology. The hope is to influence those who write these books to consider this recent material rather than the classic but now dated work of Zwaardemaker and Henning. In addition, the present review will also not concern itself with odor theories because no great strides have been made in this direction during the last decade. To some, such exclusions will mean that little information will be presented in this review pertaining to "breaking the odor code" of the "Geruchs Problem" (Schneider 112), that is, the unknown neurophysiological coding of qualitatively different odors. Instead, the emphasis will be on the less ambitious task of analyzing the psychophysics and psychology of man's ability to perceive odors. This is as important and perhaps more practically useful at this stage of development than preoccupation with the electrophysiology of the receptor cell.

The sense of smell will be given a broad definition. No attempt will—or indeed could—be made to restrict it to the activation of the first cranial nerve, which seems implied by the curious assignment of *Olfaction and Taste* as the title of the proceedings of *The Third International Symposium* of physiologists (Pfaffmann 105). The present review will also resist the temptation so common in nonphysiological discussions of the "subtle sense" of quoting poets and men of letters, but numerous examples of such wisdom can be found in two recent books (McCartney 87, Moncrieff 100). Such literary authors have had a valid point of view in their emphasis on the sense of smell in connection with feeling and motivation, while scientists working on this modality have been directed by the general assumption that this sense, like vision and audition, is a channel of intellectual information. One could make a case for classifying olfaction under a general heading of motivation rather than under sensation and perception as one of the "other," "lower," or "minor" senses. The lesson to be learned from these authors is that smell is to emotion what vision is to cognition, and toward the end of this review literature relevant to this point will be considered, although it will begin in the traditional manner with studies of sensitivity.

OLFACTOMETRY

Some still believe that little is known about the sense of smell because the stimulus is not known. This interpretation has its subtleties but refers to a state of affairs not peculiar to olfaction. A great deal of work has been done recently in instrumentation of the presentation of odorants, enough surely to satisfy those who feel psychological research starts with apparatus.

Blast-injection.—This method refers to the use of various means—a syringe, for example—to deliver a measured volume of an odorant into the subject's nostrils. Although this method has been criticized for stimulating touch as much as smell, it is still considered useful for medical purposes in controlling the location of stimulation (Schneider et al 115). However, it seems to have largely disappeared from experimental work in psychophysics.

Sniff bottles.—The simplest and cheapest, but perhaps the worst method is to present odorants diluted in water, mineral oil, benzyl benzoate, or diethyl phthalate in test tubes or beakers for the subject to sniff (e.g. Engen 31). One of the shortcomings of this method is that the physical dynamics of liquids in a container may produce great variability or disequilibrium in the vapor the subject thus inhales. Although measurement of the liquid concentration is simple, the specification of the effective variables of vapor pressure or number of molecules emitted from the container is almost impossible. One must usually assume without being able to demonstrate it that the liquid solution conforms to an ideal system according to the rules of Raoult and of Henry. For many research problems there is usually no feasible alternative method. Sniff bottles sometimes seem to indicate greater sensitivity on the part of the subject than air-dilution techniques, to be discussed below, and sometimes the opposite, depending upon the physical characteristics of the mixture of odorant and diluent (Stone 124). The rate of change of odor intensity as a function of odor concentration has been found to be different for liquid- and air-dilution systems (Cain 15, Cain & Engen 18).

Sniff strips.—Perfumers sniff odorants from strips of blotting paper which provide a more constant vapor than sniff bottles. This does not permit specification of the vapor, but it does seem to produce more reliable responses. One version of this method is to present the odorant on cotton wrapped around a glass rod (Engen 32). Another and perhaps the best modification of the sniff bottle is the "equilibrium sniffer" (Turk 135). In this case, the odorant is kept in a container with a fritted glass disk with interstices permitting a constant vapor pressure from the liquid odorant at equilibrium inside the container to be sniffed by the subject.

Except for blast-injection methods, these methods depend on the subject to keep the flow rate constant from trial to trial. This is important because, although the really effective physical or chemical attribute of the odorant is not known, Tucker (133) has shown with animal preparations that flow rate together with concentration and the nature of the odorant are basic. Subjects can be trained to sniff with sufficient constancy for quality experiments where this variable is less crucial. However, in experiments with odor intensity at the threshold level, one will find that the subjects tend to sniff harder and thus increase the flow rate and hence the likelihood of detection at the expense of the overall reliability of the response (Cain 16, Cain & Engen 18). Köster (77) has devised a clever system to eliminate this problem by making the subject sniff with a constant and moderate force. Essentially the device consists of a wedge used as a stopper in a spherical chamber in the tubing. The wedge is lifted up when the subject sniffs from a nose piece attached to the tubing, allowing the vapor to come through. Yet when the subject sniffs too hard, the wedge will block the tube at the other end of the spherical chamber and thus block the flow altogether.

The problems of odorant presentation are important but they are not insurmountable and may have been overemphasized to the extent that students have been discouraged from entering the field. Some of the instrumentation developed in olfaction is in fact very elegant.

Olfactometers.—The more refined methods dilute the odorant in air rather than liquid with another carrier gas sometimes being required, depending on the nature of the odorant. These techniques are known as olfactometers. The concentration of the odorant is varied by adding known amounts of the odorant, calibrated, if possible, by gas-liquid chromatographic techniques or by measuring weight loss for a specified duration, flow rate, and temperature. There are several variations in construction, but the main differences are well represented by the olfactometers designed by Köster (72, 76), Stone, Pryor & Steinmetz (131), and Eyferth & Krueger (43). Johnston (58) should be consulted for a detailed review of this topic. In addition to such problems as using glass versus Teflon tubing in considering problems of absorption, ease of washing, and expense, there are three basic variations in design which seem especially important in evaluating their practical applicability.

The first concerns the space surrounding the subject. Based on the old idea of a "camera inodorata," some air-dilution olfactometers are used in conjunction with a cubicle for subjects made of glass or plexiglass (Stone et al 131). Some are concerned that molecules may be lost through absorption on the walls of this kind of cubicle and thus influence the precision of the measurement of the odorant; they prefer to present the diluted odorant to the subject more directly through a tube, funnel, or nose piece for sniffing or inhaling through the nose (Eyferth & Krueger 43, Köster 72).

A second major difference in designing olfactometers concerns the use of capillaries and constant air flow (Köster 72, 76) as opposed to flowmeters and variable air flow (Eyferth & Krueger 43, Stone et al 131). Each capillary, providing one concentration, must be calibrated separately. This method provides the greatest precision in the sense of the reliability of concentration presented, but it requires much time and is less flexible than varying the concentration by adjusting a flowmeter. One disadvantage of the flowmeter is that it depends on the accuracy of the adjustment, and perhaps a more serious disadvantage is that the physical dynamics of such systems are not well understood, for the float in the flowmeter may be fluctuating without the experimenter being able to stop it or to account for it. Those who propose the use of flowmeters state that satisfactory control can be obtained experimentally through trial and error (Eyferth & Krueger 43).

The third difference concerns multichannel as opposed to single channel instruments. Olfactometers are usually limited, compared with the liquid dilution techniques described above, to the study of the intensity of only a few different odorants—one channel being required for each. They are also expensive, but if money is no object, of course these problems can be overcome. The Eyferth-Krueger olfactometer (made in Germany) is a programmable, multichannel instrument capable of presenting any one of a wide range of concentrations for any one of 24 different odorants on a given trial and with short intertrial intervals with the opportunity of monitoring each odorant gas chromatographically. See Cheesman & Kirkby (21) and Springer & Hare (120) for multichannel olfactometers for testing groups of subjects. The latter describes the so-called "sniffmobile," a sophisticated mobile laboratory designed for study of diesel engine exhaust odor but adaptable to other uses. A flexible mobile laboratory, similar to the Eyferth-Krueger apparatus described above, was designed in Sweden (Lindvall 84). See the report of the Third Karolinska Institute Symposium on Environmental Health (65) for apparatus and methodology for the detection of air pollutants.

Artificial noses.—Combined with the advance in odorant presentation there have been technological advances in building odorant detectors to supplement noses. For example, in a military application such instruments could be built to detect odors characteristic of an enemy because of his peculiar diet. The development of analytic methods, especially gas chromatography, infrared spectroscopy, and mass spectrometry (Wright 141), have suggested some promise of replacing the human nose in many practical situations. Of course, since the crucial attribute of the molecule is not yet known, such efforts tend to be limited to fairly specific substances where such analytic methods are known. For a review of such research, see Dravnieks (26).

ODOR INTENSITY

Psychophysical function.—Whether one is interested in the neural transduction mechanism or air pollution, knowledge of the mathematical form of the relationship between concentration and perceived odor intensity would have high priority. The last decade has seen great progress in such psychophysical research and the simplicity of this "new psychophysics" and its direct scaling methods (Stevens 123). This development has been especially helpful in the study of smell, where it is difficult to vary the stimulus quickly in small steps as required by classical psychophysics which limited itself to detection and discrimination. Since psychophysical laws are not of the kind one can repeal, the validity of Fechner's logarithmic function is still assumed by some, especially nonpsychologists (Appell 4, Hainer 47). The results obtained with a great number of different methods of odor presentation, odorants, and psychophysical scaling procedures, from Jones (60) to Henion (56), indicate the superiority of Stevens' power function. (According to Stevens, perceived odor intensity grows as a function of stimulus intensity raised to some power.) This power, or the exponent of the psychophysical function, varies for different odorants. Individual differences in the exponent have been observed in this modality as in others, but these appear to reflect genuine differences in perception rather than response bias, as many have been inclined to believe [see Berglund et al (9) for a summary of such studies]. The remaining and most basic psychophysical problem is how to account for the differences in exponent associated with different odorants in terms of their physical and chemical attributes.

For more limited sets of odorants—homologous alcohols, for example—decreases in the exponent have been found to be related to chain length and thus perhaps to oiliness (Henion 52, 53) or water solubility (Cain 15; Engen 31, 32; Rovee 109). Mitchell (89) cites evidence contrary to the latter finding (Mitchell & Gregson 90, 92), but Cain (17) makes a strong rejoiner defending the conclusions for the similar odorants involved, but adds that as in the case of most past attempts to explain detection data (Davies & Taylor 23, Wright 141), a more complex physical model may be required for more diverse sets of odorants. Such a model has been proposed by Laffort (78, 79). According to this model the increase in the exponent, or the steepness of the psychophysical function, seems to be the result of the combined effect of molar volume, hydrogen bonding, and polarizability. It must be borne in mind that the Laffort formula must be considered as tentative, for it entails several parameters adjusted to fit the data. Nevertheless, the emphasis on the combined effect of several variables may represent the necessary approach. A more traditional approach is represented by Beets' (6, 7) hypothesis of "profile functional groups," which suggests that the quality of an odor depends on the profile of the molecule while its functional group determines its affinity with the receptors.

There is evidence that the power function may also fit physiological responses associated with olfactory stimulation, but the results are not conclusive (Engen 34). Døving and his colleagues have shown that electrophysiological responses for single units in the frog correlate well with psychophysical judgments of the intensities of the same odorants (24, 25). The suggestion is made that the frog may be used as a biological detector for practical or applied problems instead of the human nose which is always suspect as an instrument of precision.

Detection.—In addition to the slope of the psychophysical function, future work in psychophysical scaling may be expected to emphasize the other parameters of the power function. In vision and hearing, the power function usually fits the form $\psi = k_c(\phi - \phi_0)^n$ where ψ is perceived intensity, k is the constant depending on the choice of units, ϕ the physical intensity, ϕ_0 a value related to detection threshold or minimal concentration detectable under the experimental conditions, and n the exponent discussed above. In olfaction it is not possible to be as precise in specifying the form of the power function, largely because of problems related to ϕ_0. In audition and vision both ϕ_0 and n increase as a function of adaptation, but in olfaction only n can be said at this stage to behave predictably in this fashion. Sometimes the psychophysical function tends to become flatter rather than steeper, as in the other modalities for weak concentrations, possibly because the subject starts sniffing harder as the concentration becomes weaker and thus increases flow rate (Cain & Engen 18).

A related and more serious problem is that the tendency to make false positive judgments, or "false alarms" in contemporary detection jargon, seems from all indications to be much more likely in olfaction than in audition and vision (Berglund et al 11, Corbit & Engen 22, Engen 35, Semb 117). It is not understood why this is the case, but it could be a result of stimulus variability, difficulty in identifying odors, or a high "noise" level. The nose is far from a camera inodorata. Whatever the answer, the effect of this is undoubtedly to make thresholds higher, more variable (Pangborn et al 103), and less useful in this modality than in the others. For example, it was shown in a recent study of discomfort associated with pulp mills that there is a strong tendency to report the presence of odor when it is not there (Cederlöf et al 19). No modality may gain more from the development of a detection theory than olfaction, for the subject's criterion for what to call an odor ("yes, I smell something") is easily manipulated as the result of practice, motivation as manipulated by monetary reward, feedback information from the experimenter, and irrelevant cues, such as the color of an odorant (Engen 33, Semb 117).

An added problem may be the difficulty subjects seem to have in distinguishing between sensations of odor and taste and irritation, the latter assumed to be associated with the trigeminal nerve (Mitchell & Gregson 91). The failure of Stone & Pryor (129) to replicate Engen's (29) finding that a higher concentration of an odorant is required for recognition of the quality of an odor than for mere detection of a nondescript odor may be explained in terms of the subject's criterion of response, which was not controlled in either of the two experiments. A related study of Steinmetz, Pryor & Stone (121) showed that the effect of introducing a blank in a detection experiment is to lower the concentration required for detection, providing an example of the possibility of such control.

One might expect the same response bias to affect the difference thresholds, but no such studies have been reported. Nevertheless, the work of Stone (125) and Stone & Bosley (128) is undoubtedly both practically useful and valuable from the point of view of comparative psychophysics. It indicates that a change of about 25 percent in the concentration of an odorant may be necessary for the subject to notice that the odor intensity has changed. Using this index, the sense of smell is probably the dullest of all the sense modalities. However, the nose seems surprisingly keen and similar to hearing, according to von Békésy (138), in its ability to determine whether an odorant was presented from the left or right. Schneider & Schmidt (114) agree but believe that trigeminal and other cues may be involved.

Despite the difficulties with so-called thresholds, many still argue that such data are more objective than psychophysical scaling because they require only a simple "Yes" or "No" response from the subject (e.g. Steinmetz, Pryor & Stone 122, p. 329). They claim that the nose is a reliable indicator of the presence of an odorant in the environment, even though the observer is also affected by auditory and visual stimulation and whether he is resting or exercising (Steinmetz et al 121; Stone & Pryor 129; Stone, Pryor & Colwell 130). However, Bocca &

Battiston (13) are more inclined to conclude that threshold is affected by environmental changes, especially temperature and humidity, and by individual factors. On the other hand, Stone (126, 127) obtained data on human subjects similar to those obtained by Tucker (133) on animal preparations which indicate that external temperature may not be crucial, because by the time the vapor reaches the olfactory region it has been modified to body temperature. Regarding individual factors, the evidence indicates that odor sensitivity decreases with age (Bartalena & Bocci 5, Kimbrell & Furchgott 67). Chalke, Dewhurst & Ward (20) suggest that this may be an important factor in the increased likelihood of accidental poisoning in old age.

An oft-quoted study by Le Magnen (81) regarding the relationship between the menstrual cycle and odor sensitivity has stimulated much discussion and several experiments. Le Magnen observed that women are less sensitive to the odor of Exaltolide (a lactone of 15-hydroxypentadecanoic acid which smells like musk) during menstruation and more sensitive just before ovulation, or 7 to 9 days before the next menstrual period. Exaltolide is used as a fixative in perfumes and is apparently related to steroid sex hormones associated with the odor of urine and perspiration (Kloek 68); it could be considered a possible pheromone in the case of man. Vierling & Rock (137) report data indicating a relationship between estrogen secretion and sensitivity to Exaltoline. Köster (70, 73) also reports data supporting Le Magnen, but adds that there are individual differences in the effect related to the overall length of the menstrual cycle and that change in sensitivity does not seem limited to specific odorants. Kloek (68) also observed great individual differences and could not verify "le phenomène de l'exaltolide."

A number of other papers have a bearing on this problem. Schneider (113) concludes that women are generally more sensitive to odors than men, and Koelega's (69) findings support that conclusion. Koelega could not find a reliable relationship between the personality characteristic of extroversion and sensitivity as hypothesized in personality theory. Observations by Moncrieff (95, 96) on the relationship between odor experience and EEG has not yet produced any reliable correlations. Interesting but inconclusive clinical observations attempt to link odor perception to sex and repression (Kalogerakis 64; Rosenbaum 108; Rubert, Hollender & Mehrhof 110).

Self-adaptation.—Olfaction is often described as a sense modality characterized by the effect of adaptation. This is usually illustrated with a short description of a person entering a room who notices an odor which then quickly decreases in intensity and fades below threshold. This is an anecdote which has been repeated in so many textbooks that it is apparently accepted as fact. It is not that simple.

Adaptation may be expected to affect the ability of the subject to detect the odor, the rate at which the perceived odor intensity grows as a function of increase in concentration, or by the perceived intensity of any suprathreshold concentration. The most relevant experiment for the latter situation is by Ekman and co-workers (28). They asked subjects to report on the perceived intensity of a constant concentration of an odorant (0.7, 0.9, 2.6, or 6.4 ppm of hydrogen sulphide). The results indicate that perceived intensity decreases exponentially; that is, the odor did not disappear but reached a new asymptotic level after 4 minutes.

Similar results were obtained by Cain (16) in scaling homologous alcohols. Continued exposure to a constant adapting odorant did increase the steepness of the psychophysical function, as expected from studies in vision and audition, and the stronger the adapting concentration the steeper the function. Yet the duration of the presentation of this adapting stimulus had only a relatively minor effect.

Steinmetz et al (122), and shortly thereafter Pryor, Steinmetz & Stone (106), in a revised self-adaptation experiment reported results similar to Cain's on the effect of concentration on self-adaptation, but in addition, they found a "substantial" effect of the duration of adaptation. Another important distinction in the results of Pryor, Steinmetz & Stone (106) is that their data do not show the rapid initial effect of adaptation observed by Ekman et al (28), and also these later findings apparently are in contradiction to their own earlier observations (131, p. 155).

The recovery from adaptation, that is, increase in perceived intensity when the adapting stimulus is removed, has also been observed in the experiments described above, but the nature of the recovery function is even less clear. Köster (71, 74, 76) believes that part of the problem may be that different receptors recover at different rates. One would expect related differences in rates of adaptation, but there are apparently no data bearing directly on this issue. Gradijan & Brebbia (46) found that the effects of adaptation and recovery are asymmetrical and suggested that a single channel electrical system may provide a useful model for such research.

It is unfortunate that different experimenters have tended to use different odorants, for it obviously makes interpretation more difficult. In addition to using the same odorants, it would also be desirable to observe more carefully the possible effects of response tendencies which might operate in these experiments. The possibility exists that when an adaptation effect has been observed it has been because the experimental situation led the subject to expect that such should be the case, that is, a bias to "miss" the signal in contemporary detection terminology. When the effect of adaptation has been small, it may have been because the experimental situation has led the subject to expect that effect and thus create a bias for "false alarm."

The same criticism applies to all but one of the experiments measuring the effect of adaptation with detection performance (Berglund et al 11). In this case, the tendency toward false alarm was estimated by occasionally interpolating trials with pure air instead of the test stimulus. The proportion of false alarms appears to have been constant for the duration of adaptation, but there were individual differences suggesting the need for a larger sample of data. The results show an effect of the concentration of the adaptation stimulus on the detectability of a previously determined threshold concentration of hydrogen sulphide, but again no substantial effect was observed from the duration of adaptation. Pryor et al (106) showed an effect for methyl isobutyl ketone consistent with their suprathreshold data, but they did not evaluate the subject's response bias, even though trials with blanks were used in the experiment.

Pangborn et al (103) found large individual differences in thresholds for 2-heptanone, but no evidence of the effect of adaptation. Köster (77) argues that there are differences in their thresholds obtained for ascending and descending series constant with an adaptation hypothesis. The problem is, however, to distinguish between sensory adaptation and (nonsensory) habituation, the explanation favored by the authors. In his own experiments Köster (77) finds evidence for self-adaptation effects both in case of concentration and duration for a range of concentrations, including values near threshold.

One conclusion on which all contemporary investigators may agree is that Zwaardemaker's work, which suggested that adaptation has a linear effect on threshold as a function of duration, was misleading. An exponential function fits the threshold data better, and it is also better than a linear function for suprathreshold data. There may also be agreement that concentration has a greater effect on the sensitivity of the sense of smell than duration. Teleologically, it does not seem reasonable that the only channel responsive to a large number of environmental agents should be limited to only a few minutes of functioning (about 5 minutes, according to classic literature) before succumbing to the effect of adaptation. There may be a mechanism whereby olfactory stimulation is varied in a manner analogous to eye movements. One potentially important experimental variable not yet explored is the manner of presentation of the odorant discussed above. Normal breathing, as permitted in some experiments, may produce different adaptation effects than procedures in which the odorant is pumped directly into the nostrils. For example, normal breathing may provide a way for the subject consciously or unconsciously to vary the stimulation by varying the depth of inhalations. Although the experiments discussed were not systematically different in the manipulation of this variable, consideration of it may help to resolve the problem.

Cross-adaptation.—Cross-adaptation, coadaptation, or selective adaptation has been used to study the specificity of odor receptors. Although it has been demonstrated that prior exposure to one odorant will decrease the sensitivity to a second odorant, by requiring a higher concentration for detection, for example, the method generally has been disappointing (Engen 30, Köster 77). Cain (16) showed that cross-adaptation data may be asymmetrical. For example, he found that pentanol had a relatively strong effect on propanol, but propanol had only a small effect on pentanol, even though they were matched in subjective intensity. No data can be cited which show symmetrical cross-adaptation effects consistent with a hypothesis of psychological similarity.

One practical problem under this heading is whether smokers are less sensitive to odors (and taste) than nonsmokers. Pangborn, Trabue & Barylko-Pikielna (104) could find no reliable differences between them in the case of vanillin and 2-butanone. Conversely, Moncrieff (99) reports that he and other investigators have found noticeable effects of smoking in the case of substances identical or similar to those found in tobacco smoke—in pyridine, for example. Possible adverse effects of the working environment have been observed for iron workers who smoke (Modica, Rossi & Sfogliano 94), and in more general terms there are effects of air pollution (Kaiser 63). Of course, these refer to chronic physiological effects as opposed to temporary adaptation effects.

Facilitation.—Another reason for questioning the validity of the method of cross-adaptation applied to the study of qualitative similarity was suggested by findings of cross-facilitation; this is the opposite effect from cross-adaptation in that an odorant may seem stronger, not weaker, following prior exposure to another odorant. This was apparently first observed for certain pairs of homologous alcohols used with young infants as subjects (Engen & Bosack 36). For example, propyl alcohol elicited a stronger response when it was presented immediately after octyl alcohol than it did following the diluent or ethyl alcohol. One can only speculate about the explanation for this finding, but it may be associated with the solubility of the odorants in relation to the characteristics of the mucous layer. Köster (77) reported he could find no evidence of such facilitation and suggested (p. 175) that the results should be verified "by different methods with ordinary subjects." This has been done (Corbit & Engen 22) using adult, well-practiced subjects in a signal-detection experiment. In addition to verifying the existence of cross-facilitation, these experiments also showed the expected self- and cross-adaptation for other pairs of homologous alcohols. The facilitation effect is apparently real, although it may only be obtained for very weak concentrations.

ODOR QUALITY

Identification.—In addition to the effect of adaptation, the sense of smell is assumed to have one other salient characteristic—the ability to identify and remember different odor qualities is reputed to be tremendous. Although textbooks often discuss this characteristic, no data are likely to be presented, save some personal anecdotes, quotes, or paraphrases from authors. However, the reputation regarding odor quality may be exaggerated. It is at least partly the result of semantic confusion of identification of a single odorant without a standard of comparison with discrimination between odorants presented simultaneously.

Regarding man's ability to identify single odorants, informational analysis indicates that man is not able to identify more than 16 qualitatively different odorants without making errors (Engen 33, Engen & Pfaffmann 41). In order to familiarize himself with each one of the odorants and eliminate any possible confusion, the subject is first asked to inspect all of them as long as he wishes. Then he is tested with the odorants presented one at a time in a random order. When the number in the set exceeds 16 the number of misidentifications begin to increase rapidly. Although these subjects were practiced students, they did not have the experience of chemists or perfumers, and many believe that such expert subjects would do better (e.g. Fuller, Steltenkamp & Tisserand 45). Jones (61) showed that this does not seem to be the case. He obtained nearly the same results with one chemist and two perfumers, all with long years of experience in their professions. Jones also practiced other subjects, but without striking improvement in performance.

As measured by the Shannon-Wiener measure of information, the channel capacity of the nose for odor quality is about 4 bits/stimulus, and certainly no more than 5 bits/stimulus for the best subject under the most favorable conditions. Another interesting item of information reported by Jones is that the perfumers chose to remain anonymous! Although there is a limit on the channel capacity of the nose, this is not to say that professional sniffers are not different from the uninitiated. A study by Harper, Land & Griffiths (51) points out that the difference between experienced and inexperienced subjects is that the latter tend to use more concrete terms than the former in describing odors; for example, experienced subjects describe benzaldehyde as "fragrant" and "sweet" while an inexperienced subject may say "almond." This is consistent with the common observation that there is no odor vocabulary and that an odor is identified by describing what it smells like or of what it reminds the observer. It is likely this problem of the verbal code rather than the afferent neural code which limits the subject's ability to identify odors.

Odor similarity and classification.—This is the task in which one might expect perfumers to excel. To some, judging and classifying odors in terms of their subjective similarity is the most basic problem of sensory psychology (Harper 48). Although some agreement on an odor glossary has been developed (Harper, Bate-Smith & Land 50), nothing of the specificity of the "primary colors" has emerged for odors. For a diverse set of about 50 odorants, as many as 40 terms may be needed to cover the range of qualitative differences, according to Harper and his colleagues (49–51). The same problem has been observed in the case of odorants which belong to the same subjective class. Johnston (59) found in a study of 24 putrid odors that as many as 9 subclasses could be established for this quality alone.

Such results do not encourage an approach whose purpose is: first, to classify the odorants in as few classes as possible based on the subjective similarity of their odors; next, to search for the physical and chemical similarity of the odorants in each class; and finally, to be in a position to consider the neurophysiological transduction mechanism.

The most prominent odor classification system—and perhaps the only remaining contender—is that based on the stereochemical theory proposed by Amoore (3). His hypothesis is that similarity of the odors of chemically and physically different compounds is related to the similarity of their molecular sizes and shapes. Originally it seemed that odorous compounds had one of seven different shapes, each of which appeared to correspond well with a different and presumably "primary odor" (e.g. camphoraceous, ethereal, etc). On the receptor side, it was assumed that there were specific receptors or sites formed to accommodate these stereochemical shapes; for example, the camphoraceous molecule would be shaped something like a ball and fit in a site shaped like a bowl, while ethereal would be associated with a shape more like a sausage and fit in an oblong dish-like site.

As a result of continued investigation of judged odor similarity and stereochemical measurements of molecules, it was first suggested that another primary corresponding to the sweaty odor of butyric acid may be needed (see Amoore 2).

Wright (141) suggested that as many as 20 to 30 specific receptors might be required to account for the ability of the nose but, as noted above, this ability is often overestimated. McCartney (87) has also criticized the theory, particularly with respect to the questionable reliability and validity of the subjective descriptions of odors and the complete lack of evidence for the existence of the receptor sites. Amoore (1–3) is pursuing the problem by studying specific anosmias which he feels may be associated with such specific receptors.

Multidimensional analysis of odor similarity.—Multidimensional analysis is a more modern approach to odor classification (80, 116, 139, 140, 142, 143). Instead of relying on different subjects to use the same glossary for odors, these techniques simplify the task by requiring only simple judgments of the similarity of the odors. The variability of these judgments is analyzed to determine the number of ways (dimensions) in which they seem to be different among the subjects, and then there is an attempt to label or characterize the perceptual experience associated with each dimension.

No generally applicable psychological dimension, and certainly no dimensional system, a so-called "odor space," has been revealed. A recent experiment by Berglund and co-workers (10) indicates evidence for individual odor spaces, but the differences between individuals were too large to consider group data. The effect of odor intensity, largely ignored in earlier studies of odor quality, was also found to be pronounced. This finding is consistent with those of Eyferth (42) and Wender (139), who explored this particular problem systematically.

Another problem with multidimensional scaling is that the subjects emphasize different perceptual attributes in different situations and for different sets of odorants. For example, for a diverse sample of odorants some odors may be judged as floral, others as putrid, etc. However, if the set of odorants should be less diverse, as in Johnston's (59) sample with putrid odors, Engen's sample of homologous alcohols (30), or mixtures of odorants (31), finer discriminations or less abstract terms may be considered by the subject. In the studies where diverse samples of odorants have been used, a hedonic (pleasantness-unpleasantness) dimension has emerged as the factor accounting for most of the variance in the similarity judgments. This suggests still another problem in achieving a pscyhological base for the quality code, because hedonic attributes of the odor may be assumed to be largely influenced by personal experience and cultural norms (e.g. Engen & Corbit 37, Shoben 118). That is, similarity judgments of odor are not limited to sensory or perceptual attributes.

It should also be noted that the mathematical models most often used for the analysis of odor similarities assume that the sense of smell is synthetic like vision in the case of color perception, rather than analytic like audition in the case of perception of individual notes of a chord. However, practical use of the nose, in such activities as cooking and making perfumes, requires the ability to identify components of mixtures, suggesting that the sense of smell is analytic.

Odor mixture.—Foster (44) apparently leans toward synthesis because he found the components of mixtures most often blended into a new, single quality.

Mozell (101) has suggested that one test of whether the sense of smell is synthetic or analytic would be to employ an odorant containing only one kind of molecule and another of the same perceptual quality but consisting of a mixture of two or more kinds of molecules. If the subjects could not tell them apart, this would be analogous to the case in which perception of a color resulting from a mixture of wavelengths may not be distinguished from that perceived in a single or a very narrow bandwidth of wavelength. Mitchell & McBride (93) inadvertently obtained information on half of that experiment when they mixed eugenol and propanol and found that it yielded a very good blend yet one so different from either component that propanol could not be used to mask eugenol. To complete the analogy, of course, one must find another pure odorant indistinguishable from the blend. Perhaps the sense of smell, like all other senses, is sometimes synthetic, sometimes analytic. Finding the answer depends ultimately upon knowledge of the stimulus.

Two classical psychological problems observed in mixtures of odorants are compensation, the complete disappearance of odor from a mixture of odorous components, and synergy, the enhancement of the intensity of one odorant when mixed with another. The experiments reported above on facilitation in odorant detection may be cases of synergy, although the usual definition of it involves mixtures where the components are thus presented simulaneously rather than successively as in the facilitation experiments (Kendall & Neilson 66). Köster (75, 76) found little evidence of synergism and agreed with Jones & Woskow (62) that synergy takes place only for weak concentrations. Köster did, however, find many instances of compensation for mixing ratios of about 85 percent for one odorant and 15 percent for the other, for example, cyclohexanone and dioxan.

As far as perceived intensity is concerned, the most typical result of mixing odorants seems to be that the intensity of a mixture falls somewhere between the sum and the mean of the perceived intensities of the components of the mixture. According to Jones & Woskow (62), this suggests that smell tends to be analytic, especially in the case of qualitatively different odors such as *sec*-butanol and amyl acetate which do not form a good blend. Even the sum of very similar odors of dimethyl monosulphide and dimethyl sulphide, according to Berglund, Berglund & Lindvall (8), smells only 60 percent as strong as expected from the perceived intensity of these odorants considered separately. In another experiment, Berglund et al (12) showed that a simple vector model in which the stronger of the components receives a larger weight than the weaker component provides a better prediction of obtained data than the average of the intensities of the components. This seems to apply to Köster's data of compensation mentioned above and, in general, to results described by related terms such as odor interaction, addition, and masking. However, the vector model does assume that the effects of the components are symmetrical as opposed to the asymmetrical effects observed in the facilitation experiments (Corbit & Engen 22, Engen & Bosack 36) where, for example, prior presentation of heptyl alcohol tended to facilitate the detection of propyl alcohol, but prior presentation of propyl alcohol tended to decrease the detection of heptyl alcohol as in a cross-adaptation.

The psychological effects of mixing odors is more than an academic problem, because the possibility exists that odorous pollutants may have synergistic effects on one another (Modica et al 94; Rosen, Peter & Middleton 107). Such practical consequences are, of course, the concern of health officials, but deodorant manufacturers are also interested. They claim to be able to mix an undesirable odorant with a desirable one to produce an acceptable or even desirable blend or to mask the undesirable odorant with a dominant or desirable one (Mitchell, Konigsbacher & Edman 88; Swaine 132). Unfortunately, no rules are provided. The working assumption seems to be that masking effects are very specific, such that one will need different deodorants for different odors.

The hedonics of odor.—Foster (44) concluded that the perceived intensity and pleasantness of an odor are negatively correlated but independent. Henion (54, 55; see also Lange 80) finds that the correlation is almost 1.0, which suggests to him that subjects may not be able to judge intensity independently of pleasantness and vice versa. Some odorants seem both unpleasant and strong to most subjects at any concentration at which they can be recognized (Berglund et al 9). When such unpleasant odorants are scaled for intensity, as discussed above, they tend to be judged strong at all concentrations, which results in a flat function (small exponent) with a high value of the parameter (indicated by k above) reflecting the choice of units. An interesting and perhaps related finding is that the range of the perceived intensity of odors, from weakest to strongest, seems much less than that of the subjective range from the most unpleasant to the most pleasant odor (Engen & McBurney 39). Moncreiff (98) has suggested that "he smells best who smells nothing" (p. 244), a reference to the general notion that odor is bad and the stronger it is the worse it is. Although the perceived magnitude of a percept in psychology has often been found to be influenced by the context in which the stimulus object is judged, the individual's judgment of pleasantness of odors may be relatively stable but may vary more from individual to individual than is the case with perceptual attributes in other modalities (Sandusky & Parducci 111).

It is often assumed that there are innate mechanisms which will produce approach and avoidance behavior, sometimes expressed in rules of survival such as "if it smells good and tastes good, eat it." Reliance upon such advice may have disasterous effects if given to small children (Engen & Moskowtiz 40). Although children at least 4 years of age and perhaps even newborn infants (Engen & Lipsitt 38; Lipsitt, Engen & Kaye 86) are able to discriminate between odors, they are much more tolerant of them than are adults. Preferences seem to be the combined effect of cultural norms and individual experiences (Engen 35). Moncrieff (98), who apparently favors a more biological explanation of preferences, still finds age the most important determiner of odor preference, followed by sex, temperament, and intelligence.

Moncrieff also claims that the needs of the body will determine what will be liked. Duclaux & Cabanac (27; see also Cabanac 14) make a strong case in attributing the pleasantness of odors (and hedonic judgments generally) exclusively to the "milieu intérieur." They argue that while sensations are dependent upon external stimulus factors, the "milieu extérieur," pleasantness is not. For example, they found that the odor of orange syrup smelled pleasant to fasting subjects, but that they gradually found it less and less pleasant, and finally unpleasant, during a period of one hour following ingestion of glucose. Throughout this period, however, they presumably were able to make reliable intensity judgments of the odor of orange syrup.

Another indication of the relation between need and odor pleasantness is considered by Kalogerakis (64) in connection with clinical and anecdotal data. His hypothesis concerns the "antisexual instinct," said to have been suggested first by James, and states that the body odor of another person may seem pleasant or unpleasant depending on whether or not the observer is sexually aroused.

Evidence that odor plays a primary role in the taste and flavor of food has been demonstrated convincingly with a clever method developed by Mozell et al (102). An air stream was flowed through both nostrils at a rate of 2.25 liter/min, thus preventing odorous molecules from reaching the olfactory receptors through the regular channels or by backing up from the mouth when eating. The subjects were required to identify each of 20 common food substances such as coffee, cherry, and lemon by taste alone. Their ability to identify them dropped dramatically from about 60 percent with the sense of smell to about 10 percent without the use of the sense of smell. In a related study, Skramlik-Berlin (119) has analyzed the effectiveness of compounds on taste vs smell and how they combine perceptually near the threshold level.

Increased concern about air pollution, both from the point of view of the effects of toxic substances and also of harmless but unpleasant and annoying substances, has stimulated psychological (Lindvall 82) as well as physical and chemical analysis (65; Turk & Mehlman 136). In Sweden complaints about odor discomfort range from 27 percent in rural areas to 78 percent in urban areas (Lindvall 83). Odor survey techniques with untrained observers have been found to provide reliable results (Horstman, Wromble & Heller 57). There are even mobile laboratories with facilities for sampling and assessing the air in any locality and then presenting it in carefully measured olfactometric quantities to local citizens serving as subjects (Lindvall 84). Another mobile laboratory presents diesel fumes from its own engine in precise doses to groups of such subjects (Springer & Hare 120).

Psychophysical scaling of odor intensity (Lindvall & Svensson 85) has influenced legislation in Sweden. The practical problem concerned how to measure the efficiency of combustion toilets, a problem of potentially great ecological value and surely basic enough for the most discerning critic of psychological measurement. The experimenters matched the unpleasantness of the odor of manure treated in such toilets with the unpleasantness of various concentrations of hydrogen sulphide. With the knowledge of the parameters of the psychophysical function, it was ruled that houses with such toilets must be at least 200 meters apart in order to reduce sufficiently the detectability of the odor!

CONCLUSION

A great deal of progress has been made in the study of the sense of smell, especially from a technological and practical point of view. The preceding example of a psychophysical study that influenced legislation is testimony to this progress.

While smell is still classified as one of the "lower" or "other" senses, it seems that the time has passed in psychology when animal psychologists study learning problems using visual cues in animals with poor vision. As for man, it is perhaps true that civilization has made his sense of smell lose much of its survival value. Yet some (e.g. Moncrieff 97) think it might still regain the importance it may once have had, and perhaps still has in so-called primitive societies, as civilized societies continue to pollute the environment.

LITERATURE CITED

1. Amoore, J. E. 1967. Specific anosmia: a clue to the olfactory code. *Nature* 214:1095–98
2. Amoore, J. E. 1969. A plan to identify most of the primary odors. See Ref. 105, 158–71
3. Amoore, J. E. 1970. *Molecular Basis of Odor*. Springfield, Ill.: Thomas. 200 pp.
4. Appell, L. 1964. Odor intensity. *Am. Perfum. Cosmet.* 79:43–48
5. Bartalena, G., Bocci, G. 1964. L'Acutezza e la fatica olfattoria in relazione all'eta anagrafica e biologica. *Clin. Otorinolaring.* 16:409–15
6. Beets, M. G. T. 1968. Odor and molecular structure. *Olfactologia, (Suppl. Cah. Oto-Rhinolaryngol.)* III (5) 1:77–92
7. Beets, M. G. T. 1970. The molecular parameters of olfactory response. *Pharm. Rev.* 22:1–34
8. Berglund, B., Berglund, U., Lindvall, T. 1971. On the principle of odor interaction. *Acta Psychol.* 35:255–68.
9. Berglund, B., Berglund, U., Ekman, G., Engen, T. 1971. Individual psychophysical functions for 28 odorants. *Percept. Psychophys.* 9 (3B):379–84
10. Berglund, B., Berglund, U., Engen, T., Ekman, G. 1972. Multidimensional analysis of twenty-one odors. *Rep. Psychol. Lab. Univ. Stockholm* 345
11. Berglund, B., Berglund, U., Engen, T., Lindvall, T. 1971. The effect of adaptation on odor detection. *Percept. Psychophys.* 9(5):435–38
12. Berglund, B., Berglund, U., Lindvall, T., Svensson, L. T. 1972. A quantitative principle of perceived intensity summation in odor mixtures. See Ref. 10, Rep. 346
13. Bocca, E., Battiston, M. N. 1964. Odor perception and environment conditions. *Acta Oto-Laryngol.* 57:391–400
14. Cabanac, M. 1971. Physiological role of pleasure. *Science* 173:1103–7
15. Cain, W. S. 1969. Odor intensity: differences in the exponent of psychophysical function. *Percept. Psychophys.* 6A:349–54
16. Ibid 1970. Odor intensity after self-adaptation and cross-adaptation. 7(5):271–75
17. Ibid 1971. Physiochemical characteristics and supraliminal odor intensity: reply to Mitchell. 9(6):478–79
18. Cain, W. S., Engen, T. 1969. Olfactory adaptation and the scaling of odor intensity. See Ref. 105, 127–41
19. Cederlöf, R., Friberg, L., Jonsson, E., Kaij, L., Lindvall, T. 1964. Studies of annoyance connected with offensive smell from a sulphate cellulose factory. *Nord. Hyg. Tidskr.* 45:39–48
20. Chalke, H. D., Dewhurst, R. R., Ward, C. W. 1958. Loss of sense of smell in old people: a possible contributory factor in accidental poisoning from town gas. *Publ. Health* 76:223–30
21. Cheesman, C. H., Kirkby, H. M. 1959. An air dilution olfactometer suitable for group threshold measurements. *Quart. J. Exp. Psychol.* 11:115–23
22. Corbit, T. E., Engen, T. 1971. Facilitation of olfactory detection. *Percept. Psychophys.* 10(6):433–36
23. Davies, J. T., Taylor, F. H. 1959. The role of adsorption and molecular morphology in olfaction: the calculation of olfactory thresholds. *Biol. Bull.* 117:222–38
24. Døving, K. B., Lange, A. L. 1967. Comparative studies of sensory relatedness of odours. *Scan. J. Psychol.* 8:47–51

25. Drake, B., Johansson, B., von Sydow, E., Døving, K. B. 1969. Quantitative psychophysical and electrophysiological data on some odorous compounds. *Scand. J. Psychol.* 10:89–96
26. Dravnieks, A. 1968. Approaches to objective olfactometry. In *Theories of Odors and Odor Measurement*, ed. N. Tanyolac, 371–408. Robert Coll. Res. Center, Bebek, Istanbul, Turkey. 572 pp.
27. Duclaux, R., Cabanac, M. 1970. Psychophysiologie.—Effets d'une ingestion de glucose sur la sensation et la perception d'un stimulus olfactif alimentaire. *C. R. Acad. Sci. Ser. D* 270:1006–9
28. Ekman, G., Berglund, B., Berglund, U., Lindvall, T. 1967. Perceived intensity of odor as a function of time of adaptation. *Scan. J. Psychol.* 8:177–86
29. Engen, T. 1960. Effect of practice and instruction on olfactory thresholds. *Percept. Mot. Skills* 10:195–98
30. Engen, T. 1963. Cross-adaptation to the aliphatic alcohols. *Am. J. Psychol.* 76:96–102
31. Engen, T. 1964. Psychophysical scaling of odor intensity and quality. *Ann. NY Acad. Sci.* 116:504–16
32. Engen, T. 1965. Psychophysical analysis of the odor intensity of homologous alcohols. *J. Exp. Psychol.* 70:611–16
33. Engen, T. 1970. *The effects of expectation on judgments of odor. Injury Control Res. Lab. Rep. ICRL-RR-70-11.* US Dep. HEW
34. Engen, T. 1971. Olfactory psychophysics. In *Handbook of Sensory Physiology, Vol. IV Chemical Senses. Part 1 Olfaction*, ed. L. M. Beidler, 216–44. Heidelberg/New York: Springer-Verlag. 518 pp.
35. Engen, T. Method and theory in the study of odor preferences. In *Advances in Chemoreception, Vol. II Human Responses to Environmental Odors*, ed. J. W. Johnston Jr., D. G. Moulton, A. Turk. New York: Appleton-Century-Crofts. In press
36. Engen, T., Bosack, T. N. 1969. Facilitation in olfactory detection. *J. Comp. Physiol. Psychol.* 68:320–26
37. Engen, T., Corbit, T. E. 1970. *Feasibility of olfactory coding of noxious substances to assure aversive responses in young children.* See Ref. 33, Rep. ICRL-RR-69-6
38. Engen, T., Lipsitt, L. P. 1965. Decrement and recovery of responses to olfactory stimuli in the human neonate. *J. Comp. Physiol. Psychol.* 59:312–16
39. Engen, T., McBurney, D. H. 1964. Magnitude and category scales of the pleasantness of odors. *J. Exp. Psychol.* 68:435–40
40. Engen, T., Moskowitz, L. 1970. *The influence of trigeminal stimulation on children's judgments of odor.* See Ref. 33, Rep. ICRL-RR-71-4
41. Engen, T., Pfaffmann, C. 1960. Absolute judgments of odor quality. *J. Exp. Psychol.* 59:214–19
42. Eyferth, K. 1965. Über die Abhängigkeit der Urteile über olfaktorische Qualitäten von der Empfindung der Reizintentsität. *Z. Exp. Angew. Psychol.* 12:209–22
43. Eyferth, K., Krueger, K. 1970. The construction of a programmable olfactometer. *Behav. Res. Methods Instrum.* 2:19–21
44. Foster, D. 1963. Odors in series and parallel. *Proc. Sci. Sect. Toilet Goods Assoc.* 39:1–6
45. Fuller, G. H., Steltenkamp, R., Tisserand, G. A. 1964. The gas chromatograph with human sensor: perfumer model. *NY Acad. Sci.* 116:711–24
46. Gradijan, J. R., Brebbia, D. R. 1969. Some dynamic aspects of the human olfactory system. *Ann. NY Acad. Sci.* 156:917–30
47. Hainer, R. M. 1964. Some suggested critical experiments in olfactory theory. *Ann. NY Acad. Sci.* 116: 477–81
48. Harper, R. 1966. On odor classification. *J. Food Technol.* 1:167–76
49. Harper, R. 1968. Some fundamental problems of odor perception and odor classification. See Ref. 26, 47–65
50. Harper, R., Bate-Smith, E. C., Land, D. G. 1968. *Odour Description and Odour Classification.* New York: Elsevier. 191 pp.
51. Harper, R., Land, D. G., Griffiths, N. M. 1968. Odour qualities: a glossary of usage. *Brit. J. Psychol.* 59:231–52
52. Henion, K. E. 1969. Subjective range of the odor oiliness of heptanol. *J. Exp. Psychol.* 82:515–19
53. Henion, K. E. 1970. Psychophysical scales of the odor oiliness of homologous alcohols. *Percept. Psychophys.* 7(6):351–53

54. Ibid 1971. Psychophysical scales of the olfactory pleasantness of homologous alcohols. 9(2-B): 234–36
55. Henion, K. E. 1971. Odor pleasantness and intensity: a single dimension. *J. Exp. Psychol.* 90:275–79
56. Henion, K. E. 1971. Olfactory intensity of diluted *n*-aliphatic alcohols. *Psychon. Sci.* 22:213–14
57. Horstman, S. W., Wromble, R. F., Heller, A. N. 1965. Identification of community odor problems by use of an observer corps. *J. Air Pollut. Contr. Assoc.* 15:261–64
58. Johnston, J. W. Jr. 1967. Quantification of olfactory stimuli, 192–220. In *Methods in Psychophysiology*, ed. C. C. Brown. Baltimore: Williams & Wilkins. 502 pp.
59. Johnston, J. W. Jr. 1968. The essential nature of the putrid odors. See Ref. 26, 115–31.
60. Jones, F. N. 1958. Scales of subjective intensity of odors of diverse chemical nature. *Am. J. Psychol.* 71:305–10
61. Jones, F. N. 1968. The informational content of olfactory quality. See Ref. 26, 133–46
62. Jones, F. N., Woskow, M. H. 1964. On the intensity of odor mixtures. *Ann. NY Acad. Sci.* 116:484–94
63. Kaiser, E. R. 1962. Odor and its measurement. In *Air Pollution*, ed. A. C. Stern, Vol. 1, Chap. 15. New York: Academic
64. Kalogerakis, M. G. 1963. The role of olfaction in sexual development. *Psychosom. Med.* 25:420–32
65. Karolinska Inst. Symp. Environ. Health, 3rd, 1970. *Methods for measuring and evaluating odorous air pollutants at the source and in the ambient air.* Rep. Int. Symp. Stockholm. 77 pp. Also in *Nord. Hyg. Tidskr.* 51(2), 1970
66. Kendall, D. A., Neilson, A. J. 1964. Correlation of subjective and objective odor responses. *Ann. NY Acad. Sci.* 116:567–75
67. Kimbrell, C. McA., Furchgott, E. 1963. The effect of aging on olfactory threshold. *J. Gerontol.* 18:364–65
68. Kloek, J. 1961. The smell of some steroid sex hormones and their metabolites. Reflections and experiments concerning the significance of smell for the mutual relation of the sexes. *Psychiat. Neurol. Neurochir.* 64:309–44
69. Koelega, H. S. 1970. Extraversion, sex, arousal and olfactory sensitivity. *Acta Psychol. Amsterdam* 34:51–66
70. Köster, E. P. 1965. Olfactory sensitivity and the menstrual cycle. *Int. Rhinol.* 3:57–64
71. Köster, E. P. 1965. Adaptation, recovery and specificity of olfactory receptors. *Rev. Laryngol.* (*Bordeaux*) *Suppl.* 86:880–94
72. Köster, E. P. 1967. Olfactomètre modifié et automatisé. *Parfum. Cosmet. Savons* 10:509–13
73. Köster, E. P. 1968. Olfactory sensitivity and ovulatory cycle duration. See Ref. 6, 43–51
74. Köster, E. P. 1968. Recovery of olfactory sensitivity after adaptation. See Ref. 26, 307–36
75. Köster, E. P. 1968. Relative intensity of odor mixtures at suprathreshold level. See Ref. 6, 29–41
76. Köster, E. P. 1969. Intensity in mixtures of odorous substances. See Ref. 105, 142–49
77. Köster, E. P. 1971. *Adaptation and Cross-Adaptation in Olfaction.* PhD thesis. Univ. Utrecht, Netherlands. Rotterdam: Bronder-Offset N.V. 212 pp.
78. Laffort, P. 1968. Some new data on the physico-chemical determinants of the relative effectiveness of odorants. See Ref. 26, 247–70
79. Laffort, P. 1969. A linear relationship between olfactory effectiveness and identified molecular characteristics, extended to fifty pure substances. See Ref. 105, 150–57
80. Lange, A. L. 1970. *Multivariata Studier I Luktperception* (Multivariate studies in olfactory perception). PhD thesis (in Swedish). Univ. Stockholm, Sweden. 127 pp.
81. Le Magnen, J. 1953. L'olfaction: le fonctionnement olfactif et son intervention dans les régulations psycho-physiologiques. *J. Physiol. Pathol. Gén.* 45:285–326
82. Lindvall, T. 1966. Bestämming av luktande luftföroreningar. *Nord. Hyg. Tidskr.* 47:41–71. English summary
83. Ibid 1969. Luftföroreningars olägenhetseffeckter. 50:65–114. English summary
84. Lindvall, T. 1970. On sensory evaluation of odorous air pollutant intensities. *Nord. Hyg. Tidskr. Suppl. 2.* 181 pp.
85. Lindvall, T., Svensson, L. T. 1971.

Unpleasantness-match in olfaction. See Ref. 10, Rep. 341
86. Lipsitt, L. P., Engen, T., Kaye, H. 1963. Developmental changes in the olfactory threshold of the neonate. *Child Develop.* 34:371–76
87. McCartney, W. 1963. The stereochemical theory of olfaction. *Soap, Perfum. Cosmet.* 36:33–35
88. Mitchell, M. A., Konigsbacher, K. S., Edman, W. W. 1964. The importance of odor as a nonfunctional component or odor—a tool of marketing. *Ann. NY Acad. Sci.* 116:685–91
89. Mitchell, M. J. 1971. Olfactory power law exponent and water solubility of odorants: a comment on Cain's (1969) study. *Percept. Psychophys.* 9(6):477
90. Mitchell, M. J., Gregson, R. A. M. 1968. Psychophysical power exponent value for the olfactory intensity of eugenol. *Percept. Mot. Skills* 26:720
91. Mitchell, M. J., Gregson, R. A. M. 1968. Interrelations of perceptual reports of smell, taste and irritance over the near-threshold range, for members of the N-aliphatic monohydric alcohol series. *Percept. Psychophys.* 4(1):13–18
92. Mitchell, M. J., Gregson, R. A. M. 1970. A re-examination of the value of the olfactory power law exponent. *Quart. J. Exp. Psychol.* 22:301–4
93. Mitchell, M. J., McBride, R. L. 1971. Effects of propanol masking odor in the olfactory intensity of eugenol. *J. Exp. Psychol.* 87:309–13
94. Modica, V., Rossi, M., Sfogliano, C. 1964. Danni olfattivi da inalazione di vapori e fumi metallici. *Clin. Otorinolaring.* 16:416–25
95. Moncrieff, R. W. 1962. Effect of odors on E.E.G. records. Part I. *Perfum. Essent. Oil Rec.* 53:757–60
96. Ibid. Part II, 825–28
97. Moncrieff, R. W. 1964. The air we smell. *Soap Perfum. Cosmet.* 37:419–20
98. Moncrieff, R. W. 1966. *Odour Preferences.* New York: Wiley. 357 pp.
99. Moncrieff, R. W. 1968. Sensory discrimination and smoking. *Food Process. Mkt.* 37:303–5
100. Moncrieff, R. W. 1970. *Odours.* Great Britain: Heinemann Med. Books. 237 pp.
101. Mozell, M. M. 1971. The chemical senses: II. Olfaction, 193–222. In *Woodworth & Schlosberg's Experimental Psychology, Third Edition,* ed. J. W. Kling, L. A. Riggs. New York: Holt, Rinehart & Winston. 1279 pp.
102. Mozell, M. M., Smith, B. P., Smith, P. E., Sullivan, R. L. Jr., Swender, P. 1969. Nasal chemoreception in flavor identification. *Arch. Otolaryngol.* 90:131–37
103. Pangborn, R. M., Berg, H. W., Roessler, E. B., Webb, A. D. 1964. Influence of methodology on olfactory response. *Percept. Mot. Skills* 18:91–103
104. Pangborn, R. M., Trabue, I. M., Barylko-Pikielna, N. 1967. Taste, odor, and tactile discrimination before and after smoking. *Percept. Psychophys.* 2(11):529–32
105. Pfaffmann, C., Ed. 1969. *Olfaction and Taste III, Proc. 3rd Int. Symp.* New York: Rockefeller Univ. Press. 648 pp.
106. Pryor, G. T., Steinmetz, G., Stone, H. 1970. Changes in absolute detection threshold and in subjective intensity of suprathreshold stimuli during olfactory adaptation and recovery. *Percept. Psychophys.* 8(5-B):331–35
107. Rosen, A. A., Peter, J. B., Middleton, F. M. 1962. Odor thresholds of mixed organic chemicals. *J. Water Pollut. Contr. Fed.* 34:7–14
108. Rosenbaum, J. B. 1961. The significance of the sense of smell in transference. *J. Am. Psychoanal. Assoc.* 9:312–24
109. Rovee, C. K. 1969. Psychophysical scaling of olfactory response to the aliphatic alcohols in human neonates. *J. Exp. Child Psychol.* 7:245–54
110. Rubert, S. L., Hollender, M. H., Mehrhof, E. G. 1961. Olfactory hallucinations. *Arch. Gen. Psychiat.* 5:313–18
111. Sandusky, A., Parducci, A. 1965. Pleasantness of odors as a function of immediate stimulus context. *Psychon. Sci.* 3:321–22
112. Schneider, D. 1968. Basic questions of odor research. See Ref. 26, 201–11
113. Schneider, R. A. 1967. The sense of smell in man. *N. Engl. J. Med.* 277:299–303
114. Schneider, R. A., Schmidt, C. E. 1967. Dependency of olfactory localization on non-olfactory cues. *Physiol. Behav.* 2:305–9

115. Schneider, R. A., Costiloe, J. P., Vega, A., Wolf, S. 1963. Olfactory threshold technique with nitrodilution of *n*-butane and gas chromatography. *J. Appl. Physiol.* 18:414–17

116. Schutz, H. G. 1964. A matching-standards method for characterizing odor qualities. *Ann. NY Acad. Sci.* 116:517–26

117. Semb, G. 1968. The detectability of the odor of butanol. *Percept. Psychophys.* 4(6):335–40

118. Shoben, E. J. Jr. 1963. Some observations on the learning of olfaction. *Am. Perf. Cosmet.* 78:44–46

119. Skramlik-Berlin, E. von 1962. Über-Geruchs- und Gesmacksstärke. *Z. Biol.* 113:227–40

120. Springer, K. J., Hare, C. T. 1970. *A field survey to determine public opinion of diesel engine exhaust odor*. Vehicle Emissions Res. Lab. Final Rep. No. AR-718, Southwest Res. Inst., San Antonio, Texas

121. Steinmetz, G., Pryor, G. T., Stone, H. 1969. Effect of blank samples on absolute odor threshold determinations. *Percept. Psychophys.* 6(3):142–44

122. Ibid 1970. Olfactory adaptation and recovery in man as measured by two psychophysical techniques. 8(5-B):327–30

123. Stevens, S. S. 1958. Problems and methods of psychophysics. *Psychol. Bull.* 54:177–96

124. Stone, H. 1963. Techniques for odor measurement: olfactometric vs sniffing. *J. Food Sci.* 28:719–25

125. Stone, H. 1963. Determination of odor difference limens for three compounds. *J. Exp. Psychol.* 66: 466–73

126. Stone, H. 1963. Influence of temperature on olfactory sensitivity. *J. Appl. Physiol.* 18:746–51

127. Stone, H. 1968. Physiological and psychological aspects of the olfactory response in man. See Ref. 26, 337–50

128. Stone, H., Bosley, J. J. 1965. Olfactory discrimination and Weber's law. *Percept. Mot. Skills* 20:657–65

129. Stone, H., Pryor, G. T. 1967. Some properties of the olfactory system of man. *Percept. Psychophys.* 2(11): 516–18

130. Stone, H., Pryor, G. T., Colwell, J. 1967. Olfactory detection thresholds in man under conditions of rest and exercise. *Percept. Psychophys.* 2:167–70

131. Stone, H., Pryor, G. T., Steinmetz, G. 1969. The design and operation of an improved olfactometer for behavioral and physiological investigation. *Behav. Res. Methods Instrum.* 1:153–56

132. Swaine, R. L. 1963. Environmental perfuming. *Am. Perfum. Cosmet.* 78:35–37

133. Tucker, D. 1963. Physical variables in the olfactory stimulation process. *J. Gen. Physiol.* 46:453–89

134. Tucker, D., Smith, J. C. 1969. The chemical senses. *Ann. Rev. Psychol.* 20:129–58

135. Turk, A. 1964. Approaches to sensory odor measurement. *Ann. NY Acad. Sci.* 116:564–66

136. Turk, A., Mehlman, S. 1968. Correlations between instrumental and sensory characterizations of atmospheric odors. *Correlation of Subjective-Objective Methods in the Study of Odors and Taste, ASTM STP 440*. Am. Soc. Test. Mater., 27–35

137. Vierling, J. S., Rock, J. 1967. Variations in olfactory sensitivity to exaltolide during the menstrual cycle. *J. Appl. Physiol.* 22:311–15

138. von Békésy, G. 1964. Olfactory analogue to directional hearing. *J. Appl. Physiol.* 19:369–73

139. Wender, I. 1970. Intensität und Qualität in der Geruchswahrnehmung (Quality and intensity in olfactory perception). *Diss. Abstr. Int.* 31:2972

140. Woskow, M. H. 1968. Multidimensional scaling of odors. See Ref. 26, 147–91

141. Wright, R. H. 1964. *The Science of Smell*. London: Allen & Unwin. 164 pp.

142. Yoshida, M. 1964. Studies in psychometric classification of odors (4). *Jap. Psychol. Res.* 6:115–24

143. Ibid. Studies in psychometric classification of odors (5), 145–54

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PERCEPTION

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The first reaction by the authors while preparing a review chapter is the stringent requirement of selectivity. Less than 30% of the more than 1000 articles originally screened from the 1970–71 literature survived our classification and selection process. Those that were chosen reflect the limitations, interests, and biases of the reviewers. The reader will note the emphasis on visual perception as well as the implicit assumption that the correlation between phenomenal and behavioral measures of perception and their neurophysiological substrate is becoming increasingly feasible following recent advances in physiological and quantitative analytic techniques.

In surveying this literature, we were struck by the large number of studies with inadequate experimental design and/or weak conceptual framework. Unfortunately, some good articles were also excluded from this review because of space restrictions and overlap with other chapters in this volume.

BOOKS AND REVIEWS

Entries which are relevant to special topics covered in this chapter will be cited later. General items include *Visual Perception* by Cornsweet (63), which places heavy emphasis on physiological and anatomical factors, quantitative methods, and the application to the visual system of the modulation transfer function and Fourier analysis. Some readers might be more comfortable if the prefix "Foundations of" had been added to the title. In any case, the book is a well-written, welcome, and valuable contribution.

The third edition of *Woodworth and Schlosberg's Experimental Psychology*, edited by Kling & Riggs (155), includes chapters by Engen on Psychophysics, Alpern on Eye Movements, Boynton on Color Vision, and two chapters by Hochberg on perception. The old complaint that there are no secondary sources on perception is rapidly evaporating. The applicability of Helson's theoretical position is explored by a number of authors in *Adaptation Level Theory*, edited

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by Appley (9). *The Intelligent Eye*, by Gregory (116), is based on a series of lectures presented on BBC television. The many readers familiar with his *Eye and Brain* (115) will find this to be a heuristic companion volume. The intimate relation between visual perception and art, developed to some extent by Gregory, is treated comprehensively in Arnheim's *Visual Thinking* (10) and Pirenne's *Optics, Painting, and Photography* (217).

In this same spirit of increasing communication between visual scientists and others for whom perception is an integral part of their daily activities, the compendium *Early Experience and Visual Information Processing*, edited by Young & Lindsley (294), should be noted. The papers were originally presented at a symposium at which the speakers were urged to "... emphasize points about which workers in other disciplines should be aware." *Vision and Highway Safety*, by Allen (3), reviews and interprets the literature of relevance to this critical problem.

INSTRUMENTATION AND METHODOLOGY

Historically, significant advances in our understanding of sensory and perceptual processes have followed the development of new measurement techniques. During the period reviewed, a number of devices have been designed for the continuous recording of accommodation. Although developed in part for clinical purposes, they open the possibility of experimental study of the accommodative response, a function of considerable biological importance which is influenced by both attentive and autonomic factors. Devices utilizing infrared reflection, based on the principle discovered by Campbell & Robson (45) are proposed by Cornsweet & Crane (64) and by Wildt & Bouman (288). An automatic refractometer has been reported by Knoll (157). The availability of low cost lasers has resulted in the availability of a technique for evaluating relative accommodation which, in contrast with previous methods, has been shown not to interfere with the amount of accommodation in force (128, 156). In contrast with the continuously recording devices, the laser method is inexpensive although it is also applicable to a wide variety of psychological problems.

With refinement in techniques of recording evoked potentials, applications to a wide variety of problems, including sensory and perceptual phenomena, have followed naturally. Evoked potentials have helped in the analysis of metacontrast, intensity-time relationships, and binocular summation (284). [For an historical summary and review, see Ludlam, Cohen & Ludlam (174) and Pitts (218).] The report by Harter & White (121), and subsequent experiments by Millodot & Riggs (194) and by Duffy & Rengstorff (75) showing that image quality and other parameters can be assessed objectively, will undoubtedly prove to be a valuable technique in both the laboratory and the clinic.

MODELS OF PERCEPTION

With the increase of our knowledge about the physiology of the visual system, models explicitly based on this physiology have been proposed by various authors. Two classifications of models can be made: (*a*) those which explore the visual consequences of the circular and antagonistic receptive fields of retinal ganglion cells (16, 122, 158, 159, 263, 271, 292, 295); and (*b*) those which discuss the role of the cortex in perception (15, 46, 91, 221, 222, 272, 283, 290). Other models have been presented but they are not explicitly related to physiological structures (150, 151, 162, 246, 274). It is evident to us that many experiments reported in the literature have been carried out by investigators not familiar with advances in our knowledge of the visual system. The belief that our "perception" results exclusively from activity in the classical retino-geniculostriate pathways and that there is a point-to-point representation of the visual world on visual cortex is no longer tenable. A given point in the visual field is being examined by hundreds of visual cells, each one carrying out a specific analysis (e.g. orientation, depth plane, spatial frequency). Evidence has suggested that there are at least two modes of analysis being performed by our visual system: pattern analysis used in identifying objects; and locus analysis used in locating objects within visual space (125, 136). The thrust of this evidence suggests that the first analysis is performed by the visual cortex and that locus analysis takes place in subcortical systems (e.g. superior colliculus). Several experimenters have suggested that the cortex is performing a Fourier analysis, i.e. transforming the spatial domain into the frequency domain (15, 46, 221, 283). This suggestion is attractive because on the one hand the relative Fourier spectrum of an object is invariant with changes in image size, and on the other hand we have no difficulty in recognizing objects over a wide range of viewing distances. The area is ripe for incisive experimentation.

Since the late 1950s, we have observed a rapid growth in our knowledge of the functional organization of subhuman visual systems. In the wake of these physiological discoveries have followed psychophysical experiments designed to discover whether or not the human visual system has properties similar to those of single cells in the cat or monkey visual systems. Weisstein summarized attempts made through 1968 to relate these two areas (281).

ORIENTATION SELECTIVITY

Single neurons in the visual cortex of the cat (132, 133) and monkey (134) are selectively sensitive to a specific stimulus orientation and all orientations are equally represented in the visual cortex (43, 133). Cells sensitive to the same stimulus orientation are arranged in vertical columns, suggesting a functional unit. These findings have sparked a search for psychophysical evidence of the existence in man of separate channels, each tuned to a specific orientation. Such evidence is drawn from five areas of research: visual masking, adaptation, tilt aftereffects, induced changes of orientation, and color aftereffects. See an exhaustive review by Appelle (8).

Visual masking and adaptation.—There is an increase in detection threshold of a test grating in the presence of a high contrast grating of similar orientation (masking) or following the viewing of such a grating (adaptation). These experiments are discussed in detail by Brown in this volume (37). Estimates based on masking experiments suggest that the orientation channels in human vision have a selectivity of ±12° around the vertical and ±15° around an oblique orientation of 45° (40). Adaptation experiments suggest sharper tuning characteristics of ±7° (42), ±6.75° (26) and ±5° (99).

Tilt aftereffects.—After viewing a high contrast grating which is tilted slightly to the left of vertical, a vertical grating appears tilted slightly to the right. Campbell & Maffei (43) measured the apparent tilt induced both in a horizontal and a vertical grating as a function of adapting grating orientation. A maximum apparent tilt of 4° was produced when the adaptation grating was ±10° from the horizontal and vertical respectively. Viewing an adapting pattern oriented near the horizontal also induced a tilt aftereffect in a vertical pattern. The maximum magnitude of this indirect effect was only 2°, but like the direct effect it occurred when the adaptation grating was ±10° from the horizontal. No tilt aftereffect was found for oblique patterns. The more variable data of Gilinsky & Mayo (99) also suggest that the maximum tilt is induced when the adaptation grating differs from the test grating by 10°.

Held & Shattuck (126) discovered that the tilt aftereffect can be color-specific. Subjects viewed red stripes tilted clockwise off vertical and green stripes tilted equally but counterclockwise. Following such adaptation, vertical test stripes appeared tilted counterclockwise when projected in red light and clockwise when projected in green. As in the above experiments (43, 99), the maximum tilt was induced by an adapting grating orientation of 10 to 15°, although the magnitude of this tilt was considerably smaller (50 min vs 4°). The Held-Shattuck discovery (induced orientation specific to color) is inversely similar to the McCollough effect (189) (induced color specific to orientation) and it may well be that the neural basis for both is the same.

Although both the tilt aftereffect and adaptation exhibit similar narrow orientational tuning, there are differences between the two phenomena: the tilt aftereffect shows perfect interocular transfer (43), while adaptation does not (22); the tilt aftereffect can be induced by a pattern 90° from the orientation of the test pattern (43) while there is no effect on psychophysical thresholds or evoked potentials following adaptation to such a pattern (42); and the tilt aftereffect is restricted to patterns oriented near the horizontal or vertical (43) while the adaptation effect on threshold is independent of test pattern orientation (42). Both neural adaptation (59) and neural inhibitory interaction (207) have been suggested as mechanisms of the tilt aftereffect.

Induced changes of perceived orientation.—A phenomenon similar to the tilt-aftereffect is the change of the perceived orientation of a test line induced by the presence of an adjacent line of different orientation. The result of this effect is an apparent expansion of acute angles. The effect is undiminished if the test line is seen in one eye and the inducing line seen in the other (29). It has been reported that vertical and horizontal lines are more impervious to induced changes than are oblique lines (29); this is denied by Blakemore et al (23), although they present no supporting data. Like the tilt aftereffect, the induced orientation change is maximum (2° shift) when the inducing line is at an angle of 10° to the test line

(23). To explain these induced changes of perceived orientation, the concept of lateral inhibition between populations of cells sensitive to similar orientations has been proposed (23), criticized (58), and defended (24). Evidence of this lateral inhibition in the cortex of the cat is found (38). The lateral inhibition proposed by Blakemore, Carpenter & Georgeson (24) should not be confused with the retinal lateral inhibition discussed by Coren (60). The similarity between induced orientation changes and certain geometrical illusions (e.g. Poggendorff, Zöllner, Wundt-Hering) suggest a common neural basis (23, 29, 38). Other explanations of these illusions, less explicitly neural, are discussed by several authors (60, 62, 82, 131, 279, 285).

Color aftereffects.—Some investigations of the McCollough effect are relevant to orientation selectively (81, 254, 255). The McCollough effect is usually induced by viewing two orthogonal grating patterns of different colors. Fidell (81) reported that the McCollough effect was minimal when the angular difference between the two induction patterns was reduced to 11°. In the normal effect, the saturation of the induced colors is halved by a head tilt of 15° (255). Since the counter-rotation of the eye was not measured in this study, the actual selectivity is probably much sharper than they report.

Horizontal and vertical orientation.—Closely linked with the question of orientation-specific channels is whether or not horizontal and vertical orientations have a special meaning in our nervous system. On the one hand, no orientation is represented more often than any other by cells in the visual cortex of cat and monkey (43, 133), while on the other hand much of the human psychophysical data indicate that vertical and horizontal orientations are somewhat special (8). Campbell, Kulikowski & Levinson (41) demonstrated convincingly that grating acuity was higher for vertical and horizontal orientations than for oblique and that these differences were not due to the optics of the eye. The effect of masking is less with oblique test targets (40). Both adaptation and tilt aftereffects show a preference for horizontal and vertical orientation (43, 99). Induced orientation effects also seem anchored to the horizontal and vertical (29, 99).

Maffei & Campbell (181) reported that the magnitude of the cortical evoked potentials were greater for vertical and horizontal gratings than for oblique while the electroretinogram was not influenced by pattern orientation, suggesting a nonretinal origin for this effect. Campbell & Maffei (43) measured the accuracy with which subjects could set a line to a particular orientation. The standard deviation for vertical and horizontal settings was 20 min of arc; it rose to 3° for oblique settings. When deprived of gravity as a cue (subjects lay on their backs and made settings using their body as a reference), horizontal and vertical orientations were less accurate (S.D. = 1.5°) but still superior to oblique orientations (S.D. = 3.6°). Perceived similarity among different textural patterns also cluster around the vertical and horizontal and is also influenced by gravity (204).

Conclusion.—The evidence supporting the existence of individual channels within the human visual system, each sensitive to a narrow range of orientations, is strongly supported by numerous psychophysical data from a wide range of tasks. The relationship between the psychophysical data and similar data for individual cells in the visual systems of cat and monkey is striking. The superiority of the vertical and horizontal in several human psychophysical tasks may mean either that our visual system has developed a functional emphasis not present in cats and monkeys or that the neural basis for these anisotropies have yet to be discovered.

SPATIAL SELECTIVITY

Companion to the issue of orientation selectivity is whether or not the visual system contains independent channels, each sensitive to only a narrow range of spatial frequencies. Here most of the evidence is psychophysical since single cells in the cat's visual cortex are rather broadly tuned (39) to sine wave gratings. As before, some of the experiments involve changes in threshold after viewing a high contrast grating (22, 26, 44, 52, 111, 112, 213, 220, 235, 257), and these are discussed by Brown in his chapter on visual sensitivity in this volume (37).

Apparent frequency shift.—Along with the threshold elevation which occurs following the viewing of a high contrast grating, there also occurs a shift in the apparent spatial frequency of a grating (27, 28). Gratings whose spatial frequencies are higher than the adapting pattern seem even higher, and lower frequencies seem lower. This effect is limited to spatial frequencies within 2 octaves of the adapting frequency. Maximum apparent frequency shift occurs at spatial frequencies about 0.5 octave away from the adapting frequency. The magnitudes of both the apparent frequency shift and the elevation of threshold are affected in identical ways by changes in adapting contrast and changes in the orientation of the adapting grating (26), implying that the same mechanism is responsible for both effects. The evidence suggests that this mechanism is a channel (perhaps in the visual cortex) responsive only to a narrow range of spatial frequencies and orientations.

Campbell & Robson (46) first suggested that these multiple channels enabled the visual system to perform a crude Fourier analysis of visual patterns. A complex pattern (either spatial or temporal) may be described in terms of sine wave components which when added together reproduce the original pattern. The magnitude, frequency, and phase relationships of these component sine waves uniquely describe a pattern and allow a basis for exact comparison with any other pattern. Campbell & Robson proposed that the various sine wave components of a complex pattern are handled independently by the visual system. Just above threshold a square wave grating (which contains sine wave components at the odd-harmonic frequencies, in addition to the fundamental) appears identical to a sine wave grating of the same spatial frequency, presumably because only the fundamental of the square wave is above detection threshold (46). Viewing a high contrast square-wave grating causes both an increase in threshold (22) and an apparent frequency shift (27) at frequencies which are three times the fundamental. A sine wave pattern causes similar effects only at its fundamental frequency.

We are at a point now where it is fruitful to think of visual stimuli in terms of their Fourier components. In Fourier terms, a single bar is not the same stimulus as a sine wave grating. The single bar contains a wide spectrum of spatial frequencies whereas the grating contains only one. This point is made in an elegant experiment by Sullivan, Georgeson & Oatley (257), who measured the increase in threshold to sinusoidal gratings after viewing either bars 7.5 or 1.25 min wide or gratings of 5.5 or 16 cycles/deg. Since the bars generate a broad Fourier spectrum, they cause a reduction in sensitivity across a wide range of spatial frequencies, while the sinusoidal gratings have an effect over a narrow range. The small test spots typically used in increment threshold experiments have a broad Fourier spectrum. This fact undoubtedly leads to the broad spatial tuning curves derived by Thomas and his associates (12, 263, 264).

Although evidence indicates that at threshold the visual system behaves as if it were a linear system, it is clearly nonlinear at suprathreshold levels. One manifestation of this nonlinearity is the enhancement of the border between two areas of different luminance. This perceptual darkening and brightening which occurs near a border (Mach bands) is often asymmetrical: the bright band appears brighter than the dark band appears dark. Whiteside & Davidson (67, 286) found that if the luminance gradient between the light and dark areas is exponential, the resulting Mach band appears symmetrical. They suggest that the output of retinal receptors is a function of the logarithm of the luminance and that by using an exponential luminance gradient, this nonlinearity is cancelled out.

In Fourier terms, the effect of any nonlinearity in a system is to create harmonic components in the output that were not present at the input. In terms of spatial frequencies, the apparent sharpness or distinctness of an edge can be enhanced by the addition of these upper harmonics. Kaiser has argued effectively that minimal border distinctiveness is a criterion more meaningful than equal brightness in both heterochromatic (144) and achromatic brightness matching (145). That this criterion is accurate suggests that information about the presence of these upper spatial harmonics is readily available in the visual system. Keesey (149) Fourier analyzed the cortical potentials evoked by high modulation sinusoidal flicker. Most of the energy was in both the first and second harmonics, with 10% in the third and fourth harmonics. We think that these techniques offer much potential for understanding the transformation of the physical stimulus at the retina into information used by the brain.

FORM AND PATTERN PERCEPTION

Two types of pattern perception research have developed, using wholly different methodologies. One type exploits the methods of signal detection theory, linear discriminant analysis, and other multidimensional techniques. The other type of research continues to follow more traditional methodology which is known to have serious flaws that confound the interpretation of results. Fortunately, van de Geer has written an excellent introduction to the techniques of multivariate analysis (270), and Dodwell's book is filled with examples of their application (74). We feel that the use of these techniques offers experimental power not previously available and generates the potential for breakthroughs in our knowledge. Zusne (296) provides an exhaustive summary of the literature on form perception.

A pattern or form may be described by one point in a multidimensional space, where each dimension is some physical attribute of the form (e.g. area, size, number of sides). As many as 80 such dimensions have been used in the description. Subjects may then be asked to perform a recognition, sorting, or other task using any such patterns. With the aid of multidimensional techniques, one may infer which properties of the stimulus patterns were important for the subject's performance of the task and which properties were irrelevant. This inferred use of visual information is independent of the subject's verbal description of his performance.

Owen & Brown (209, 210) generated random forms with a computer and displayed them visually to 40 subjects and tactually to 40 others. All subjects were asked to rate the forms on complexity. Analysis of the results showed that the same pattern features were used in both the visual and tactual tasks. Although intrasubject comparisons were not made in these experiments, Owen & Andolsek (208), using similar techniques, reported high reliability in the way each subject used visual cues. Aiken & Brown (1) gave subjects 60 computer-generated figures and asked them to sort these figures into groups so that each group was as homogeneous as possible. Sortings of two to nine groups were made. The results of the sortings were analyzed in a stepwise discriminant analysis. It appears that a subject is limited to only three stimulus attributes that he is able to use simultaneously in a task of this sort. In another experiment (2) subjects had to classify forms which had been derived from one of two prototype forms. By controlling the variability of the derived forms, the task was made easy (low variability) or difficult (high variability). An important finding was that the incorrect behavior was not random. When the task was too difficult for correct performance, the subjects began to classify the patterns presumably according to their own internal rules in an attempt to create some order in their behavior.

Other experiments affirm the importance of the physical measures of form in determining the psychological dimensions of form which in turn determine the response of subjects in a variety of tasks (36, 173, 185–188, 224, 245). Although the physical characteristics of form have been used most often, there are other possibilities for the classification of visual forms. Perhaps it would be fruitful to use the Fourier spectra of patterns taken at different orientations as the multidimensional description.

Although verbal mediation was reported to be unimportant in the recognition of homogeneous pictorial stimuli (107), it can be a factor in the encoding of nonsense forms (56, 223). Leeuwenberg (170) has presented a formal coding language for both two and three-dimensional visual forms and auditory patterns as well. The approach of multidimensional processing is presented by Kaufman & Levy (147), probability matching by Thomas & Legge (262), and cluster analysis by

Jardine (139–141). Garner (95) applies the concept of redundancy to the Gestalt concept of goodness. Weintraub discusses rectangle discriminability within the context of the law of Prägnanz (277).

The perception of the human face continues to receive attention. The recognizability of a face is correlated with increases in perceived beauty of the face (66) and number of critical features (30, 31). Viewing negative or positive images has little effect (31, 94). Smith & Nielsen investigated the role of number of features relative to the subject's memory decision for line drawing of human faces (243). The results suggest that different retrieval processes underlie "same" and "different" judgments and that retrieval in recall involves verbal representation. Inversion of faces reduces recognition (31). Yin (293) suggests that damage to the right posterior hemisphere of the brain creates a special deficit in the recognition of faces, compared with other material. These results were confirmed by Tzavaras, Hecaen & LeBras (266, 267).

An internal image has some properties of a real object. Shepard & Metzler (241) found that the time required for a subject to correctly identify two different perspective drawings of the same three-dimensional object was a linear function of the angular differences between them, suggesting a finite time to "rotate" one of the mental images. Segal & Fusella (237, 238) found that subjects' sensitivity (measured by d′) for auditory and visual signals was reduced while they were imaging mental pictures and sounds. It was suggested that imagery acts as an internal signal which is confused with the external stimulus. The reports of eidetic imagery give support to this interpretation (21, 256). Stromeyer & Psotka's (256) eidetic subject was able to combine the real image of a Julesz random-dot stereogram seen in one eye with the eidetic image of its pair seen previously with the other eye, forming a stereoscopic image of the two. In this case the eidetic image behaved as if it were a real image presented to the eye. Random-dot stereograms are a very strong test of eidetic imagery, and the demonstrated ability of their subject serves as a rude reminder of how little we know about visual processing and imagery storage.

Eye movements and pattern recognition.—Noton & Stark (202, 203) maintain that the sequence in which eye fixations are made while looking at a pattern is important for later recognition of that pattern. Their main finding is that subjects repeat sequences of fixation (called "scanpaths") while viewing line drawings. They suggest that a pattern in stored in the brain as a piecemeal collection of features which are processed serially in an order determined by eye fixation, and that when seen a second time, the pattern is recognized only if the same sequence of fixations is followed. These data have limited applicability to normal perception for the following reasons: the authors only assert that scanpaths occur, but present no quantitative data for support; pattern recognition occurs with tachistoscopic presentation where eye movements are not possible; pattern recognition could be a piecemeal analysis of features without being serial; and most importantly, the authors fail to show that a failure to recognize a previously viewed pattern is associated with a corresponding failure to repeat the previously followed scanpath. See also the criticism of Spitz (249) and the reply by Stark & Noton (251). In a study by Virsu (273), eye movements were related to errors in perceived location of intersection in arc figures, but the same technique when applied to the Müller-Lyer illusion was only partially successful. In general, attempts to relate eye movements to higher perceptual functions have been disappointing.

STABILIZED IMAGES

Images may be functionally stabilized on the retina in three ways: stabilization with contact lens projection; steady fixation under low illumination; and afterimages. Only the last provides a truly stable image. Patterns viewed under these conditions fade from view, then return wholly or in part (fragmentation), fade again, etc. Fragmentation can even occur in unrestricted vision under stroboscopic illumination (216). The fragmentation of a pattern occurs nonrandomly (179, 180, 193) and is dependent upon characteristics of the pattern (49, 65, 236). After 10 years of research it is surprising that only now has a systematic investigation of the fading and fragmentation process been attempted. Using contact lens stabilization, Schmidt, Fulgham & Brown (236) found: that of 24°, 45°, 90°, 135°, and 165° angles formed by two lines, one of which is horizontal, the 90° angle fades least; a single line fades least when it is horizontal or nearly horizontal; a right angle formed by two lines fades least when the lines are horizontal and vertical; the orientation of acute angles has no systematic effect on the amount of fading. These findings suggest that the fading process is mediated by mechanisms important in pattern perception.

Still missing, however, is knowledge about the effect of eye movements on the fading process. Gross eye movements contribute to the suppression of afterimages (152). Most important, however, is the discovery that normal vision is maintained by the slow drifting movements of the eyes rather than by other movements (97). The experimenters first stabilized the image with a suction contact lens and then simulated the drifts, saccades, and tremor which accompany normal eye fixation by moving the image of the target. The saccades and tremor had no effect while the slow drift restored the faded stabilized image. The next step should be to relate each occurrence of image fragmentation with the direction and extent of the eye movements which precede it.

Although some retinal processes take part in the fading (50, 160), experiments using dichoptic presentation of patterned afterimages clearly implicate mechanisms at the level of binocular integration (20, 114, 184, 211, 215). Further implication of central mechanisms is provided by Gerrits & Timmerman (96), who reported that an annulus which surrounds a retinal scotoma is instantly filled in and is perceived as a disk by the patient. Gerrits & Vendrik (98) simulated a scotoma by a stabilized black disk on the retina. After a few seconds the disk filled in and appeared to be the same brightness as the surround. The delay in the filling in of the stabilized disk was attributed to some receptor activity at its edge which acted as a barrier to the more central process. The adaptation that occurs upon viewing a grating pattern can be viewed as due to fading of a stabilized cortical image (25).

MOTION PERCEPTION

Studies of the perception of motion are classified according to whether the motion is generated by a moving visual stimulus, by sequential stimulation of separate retinal loci, or by an aftereffect following the viewing of real movement.

Real movement.—Henderson (127) analyzed the interaction among time, distance, and luminance in determining motion threshold. He found that for equal movement thresholds there was an inverse power relationship between exposure duration and the distance moved. Energy constancy at threshold was confirmed only for high velocity/low luminance stimuli. Kinchla (153) tried to relate perception of length with perception of motion by making a distinction between absolute and relative motion, but he did not distinguish between the separate meanings of the stimulus for motion (spatial displacement with time) from the subjective impression of motion. Oyama's (212) subjects made velocity matches with moving stripes. Matched velocity decreased as field of view and stripe width increased. He further reported that at high velocities, horizontal movement seemed slower than vertical movement. These data contrast with Kinchla & Allen's (154) finding that motion thresholds for vertical and horizontal movement are identical. The luminance threshold for a downward moving grating is equally affected by previous adaptation to downward motion intermixed with either stationary gratings or upward moving gratings (239). Kano (146) measured motion thresholds for objects subtending equal visual angles but viewed at different distances. The velocity thresholds increased with distance but less than would be expected on the basis of retinal image velocity. The compromise between predictions based on proximal and distal stimulus characteristics is similar to many constancy studies.

Motion toward a subject (simulated by expanding geometric figures presented on film) elicited larger orienting responses than motion away (18). The relative contribution of three motion-parallax cues to perception of the direction of rotation in depth of a line (simulated in polar coordinates by computer) was investigated (129). Subjects performed above chance using only the differential velocity of the near vs far ends of the line. Braunstein (34) reported that subjects give highest accuracy in judging the direction of rotation when figures contain right angles. Graham & Gillam (110) present evidence supporting the assumption that reversals of the Ames trapezoidal window follow perspective indications when angular velocity cues are ambiguous.

Apparent movement.—Apparent movement occurs when two retinal loci are successively stimulated. Kahneman & Wolman (143) maintain that optimal perceived motion is independent of stimulus duration: for stimulus durations less than 100 msec, optimum motion occurred when the onset of the two stimuli was separated by 120 msec. For longer stimuli, optimum motion occurs when the second stimulus begins at the termination of the first. Kaufman et al (148) suggest that the biological effect of apparent motion is to extend the range of motion perception of the visual system. They maintain that apparent motion does not parallel real motion because the real velocities corresponding to the interstimulus interval would appear blurred. In fact, apparent motion can be generated by two stimuli whose spatial separation cannot be resolved when they are presented simultaneously in peripheral vision (19).

If two stimuli which differ slightly in shape (instead of identical shapes) are used to create apparent motion, subjects resolve the resulting disparity in three ways: translation, deformation of contours, rotation of the shape in depth (161). The direction of apparent movement between two granular patterns reverses if one pattern is the photographic negative of the other (Anstis 6). Anstis also presented Julesz random-dot stereograms dichoptically (to generate stereopsis) or alternatively to one eye (to generate apparent movement). When random noise was introduced into one pattern, Anstis reported that both stereopsis and apparent movement broke down at the same noise level (6). Thus apparent movement seems to depend on a point-by-point comparison of brightness between two patterns.

Motion aftereffect (*MAE*).—After one views a moving pattern, a stationary pattern appears to move in the opposite direction. One explanation for this aftereffect could be adaptation of motion sensitive elements which serve the retinal area stimulated. However, Day & Strelow (69) report that the MAE generated by vertical stripes moving horizontally is greatly reduced and even eliminated if the stationary test stripes lack a pattern surround. A further study by Strelow & Day (253) showed that the MAE can be turned on and off by the presence or absence of a patterned surround, indicating that though motion is not visible, the aftereffect is stored somewhere in the visual system. Three clever experiments by Anstis & Moulden (7) indicate that the MAE has both retinal and central components. When each eye was adapted to rotating motion in opposite directions, the direction of the MAE was specific to the eye viewing the stationary pattern. When it was arranged that each eye alone saw a random oscillation, but the two eyes together saw counterclockwise rotation, a clockwise MAE was seen. Finally, if each eye alone saw clockwise rotation but both together saw counterclockwise rotation, a clockwise MAE was seen indicating central origin (7).

Interactions.—The interrelation between movement and other modes of perception is illustrated by Brandt, Wist & Dichgans (33), who seated subjects inside a large drum with black and white vertical stripes on its inner surface. The chair and/or the drum could be rotated. Subjects could not distinguish between drum and chair rotation and attributed all movement as self-rotation. Tilting of the head during rotation of the drum produced a "pseudocoriolis" effect which was indistinguishable from the coriolis effect produced by pure vestibular stimulation (rotation of the chair). Gogel & Koslow (104) have demonstrated that both stereoscopic depth and the adjacency principle have an effect on the motion induced in a stationary point of light by a moving frame. A moving rectangle decreases in apparent length parallel to the direction of movement (259). At any point in time the apparent position of a moving spot is displaced in the direction of the movement (258).

Mechanisms of movement.—A question still unresolved is whether perceived motion generated by real movement, by apparent movement, and as an aftereffect are due to the same visual mechanism. The results of the apparent movement experiments of Biederman-Thorson, Thorson & Lange (19) suggest that its basis is the same as real motion. Kaufman et al (148) argue that apparent motion and real motion have separate mechanisms. Richards (231) assumes that the mechanism for MAE and real motion detection are identical and presents psychophysical evidence that motion detection is the responsibility of subcortical areas of the brain (e.g. superior colliculus). This conclusion contrasts with the data of Hamilton & Lund (119), who sectioned the chiasma and forebrain commissures of monkeys and demonstrated that interocular transfer of a motion discrimination task depended upon intact cortical functions. It is clear that both central and peripheral factors are involved (7) and that adaptation effects are not simple fatigue of direction specific units (69, 253). The most comprehensive and successful model of motion detection by the visual system is that of Foster (88, 89).

EFFECTS OF EYE MOVEMENTS ON PERCEPTION

Perception during eye movements.—The old problem of perception during eye movements, which Woodworth noted had been debated energetically during the early part of the century but had subsided in the 1930s (291), continues its resurgence of interest among contemporary investigators. The older debate attributed the reduced perceptual experience during eye movements either to inhibition ("central anesthesia") or to smearing of the retinal image. On the basis of recent experiments, both these factors are implicated, and additional mechanisms have been suggested.

Color recognition during a saccade was found by Lederberg (169) to be best when the flash is presented during steady fixation, somewhat poorer just before a saccade, and still poorer after a saccade. Since recognition of colors was not impaired when the subject moved his hand to trigger the stimulus flash during steady fixation, it follows that a specific inhibition accompanies eye movements but not other attention-diverting motor activities. These data are consistent with previous results which demonstrated partial suppression during saccades. Richards (229) noted changes in hue towards the yellow when an achromatic test flash was presented following a saccade. These results, taken along with Lederberg's (169) finding that the poorest recognition of red and green test flashes occurred in the middle of a saccade but that maximum inhibition of blue occurred 40 to 80 msec later, suggests that the time course of inhibitory processes during saccades are wavelength dependent. These results may be of relevance to the Benham disk color phenomenon.

That saccadic suppression is not affected by shifts of the observer's criterion was reported by Pearce & Porter (214), who demonstrated a decrease in sensitivity beginning as much as 150–200 msec prior to a saccade using criterion "free" signal detection techniques. It is becoming increasingly clear that perception during eye movements is influenced by both inhibition and retinal image smearing. A series of studies from Mitrani's laboratory provides additional confirmation of the importance of both of these factors. He reports that smearing during horizontal eye movements is greater for vertical than for horizontal bars (195), that suppression at the beginning of a saccade is greater the longer the saccade (198), that the time course of suppression is different in various parts of the retina (196), that suppression disappears at high luminance levels and increases with nonuniform stimulus presentation. He concludes that saccadic suppression is not a simple matter, but depends on the motion of the entire visual pattern (197, 198). Mack (175) investigated the relation between eye movements and retinal image movements whose ratio and direction were systematically varied. She reports that a discrepancy between eye and target movement greater than 20% results in target movement perception.

Recent experiments have implicated additional mechanisms underlying this phenomenon. Richards (227) presented evidence that one cause of inhibition may be mechanical strains set up in the retinal layers by the rapid acceleration during a saccade. MacKay considered the intriguing possibility that this disturbance may be, in part, neural. In support of his position he has shown that with the eye stationary, rapid movement of the stimulus produces suppression (177). Since the effect was obtained dichoptically (178), central factors are implicated. He suggests that the surge of neural activity caused by rapid displacement has side effects that interfere with the processing of visual signals.

Noda and co-workers report that about 10% of the cells in the visual cortex of awake cats do not respond to stationary or moderately moving stripes, but are either excited or inhibited during saccadic eye movements when the animal faces a patterned environment (200). Neurons which responded to slower target motions were directionally sensitive, while those that responded to the more rapid motion produced by saccades were insensitive to the direction of retinal image motion. In effect, neurons that function during saccades do not function during perception, a finding which corresponds nicely with the psychophysical evidence. Additional neurophysiological correspondence comes from Chase & Kalil's study of visual evoked responses which indicates suppression of responses to lights or patterns presented during saccades (53).

VISUAL SEARCH

The role of advance knowledge and previous practice on search efficiency was common to a number of experiments. In a study concerned with the maximum rate of scanning letters in the presence of a numeral, Sperling et al report that advance knowledge of the numeral to be presented made little difference in the scores (247). Scanning rates of as high as 125–175 letters per second were reported for their best subjects under certain conditions. Krueger reports that familiarity with a sequence of letters aids visual search. Subjects search more rapidly for a target letter through words than nonwords (166), and more rapidly when familiarity is introduced by repeated presentation of certain sequences or displays (167).

The contribution of eye movements per se was investigated by Grindley & Townsend (117), who report that search for targets during exposures too brief to permit eye movements is aided by foreknowledge. They conclude that something analogous to visual search can occur without eye movements.

A number of studies were concerned with the mode of comparison during search activity. An experiment by Graboi (109) investigated the dichotomy between serial processing, i.e. that a test item is compared serially with the memory of every other item in the set as contrasted with parallel processing, i.e. that the test item is compared simultaneously with all members of the memory set. The extent to which the data tended to agree with these two positions depended upon the amount of previous practice. The author proposes a single memory search process to account for the data under both high and low levels of specific practice. Cohen's (54) subjects cancelled targets that were visual (letters), acoustic (phonemes), or semantic (words of a specific category). Semantic processing added little or no extra time when combined with acoustic or with visual and acoustic searches, i.e. parallel processing. An overlapping sequence of operations is suggested by results from combinations of processing which yield slightly faster search times than a serial model would predict. Stone (252) considered various models for comparison of multivariate visual stimuli: parallel vs serial processing, efficient vs exhaustive comparisons, and biased vs unbiased acceptance of attributes for processing. The data, obtained from two comparison tasks involving matching to sample and identification of odd stimuli, supported the position that parallel and efficient comparisons were the rule along with a kind of partial selection of the attribute to be processed. Investigators interested in distinguishing between serial and parallel processing should read Townsend's (265) discussion of the theoretical difficulties surrounding such an effort.

Doubt was cast on the role of feature analyzers as an explanation of high speed scanning by Brand (32), who found different scanning rates for two precisely defined targets depending on the class from which they were drawn. In contrast, Gould & Peeples (108) concluded that pattern discrimination during visual search is based upon physical rather than meaningful characteristics since the class to which a pattern belonged did not affect any of four measures of search efficiency. (See also the section on form perception in this chapter.)

BRIGHTNESS

Contrast and interaction.—Based on a parametric study of the effects of amount of surround of the inducing field and separation between test and inducing fields on simultaneous contrast, Cole & Diamond (55) report that test-field brightness is not affected by amount of inducing field surround when the separation between the centers of the test and inducing fields is held constant. The critical variable is the separation between test and inducing fields. The functional relation between test field and background was found by Flock (84) to follow power functions with positive exponents. The relevance of these data to Jameson & Hurvich's opponent-process theory is debated in this and two subsequent publications by Jameson & Hurvich (138) and by Flock & Noguchi (85) as well as by

Noguchi & Masuda (201). Semmelroth (240) also considered the relation between stimulus luminance and its surround to be a power function. His data are treated theoretically within a framework which includes results from studies on crispening and previous magnitude estimation and partitioning studies of lightness and brightness.

The contribution of higher level processes continues to attract interest. Mershon & Gogel (192), in a follow-up study to their demonstration (105) that depth adjacency contributes to the Gelb effect, verified the original result and confirmed that the reduction in contrast was not due to the small directional displacements necessary to produce the stereoscopic cue. Their phenomenon, which represents an extension of Gogel's adjacency principle (101), implicates the involvement of depth perception rather than the stereoscopic cue per se, and points to the importance of central factors. Methodological problems related to the experiments are discussed by Lie (171) and by Mershon (191). Within the paradigm of the Gelb effect, Beck's (17) subjects judged the lightness of equally illuminated targets. They perceived the targets that cast a shadow as darker than those that did not, confirming earlier findings that the perception of lightness may be affected by cues for the conditions of illumination as well as by the inhibitory interactions underlying contrast.

The conditions that produce brightness assimilation, the opposite process of contrast, were investigated by Festinger, Coren & Rivers (80). Assimilation was found only under conditions in which the portion of the display being compared was not the focus of attention. When attention was focused, brightness contrast was obtained. The subtleties of assimilation were also investigated by Kozaki (163) in an experimental arrangement that systematically varied a number of spatial parameters. He reports that depending on the reflectance of the background, the effects of assimilation and contrast could be reversed even when other parameters were held invariant.

The role of brightness in figure-ground relationships was investigated by Coren (60), who concluded that the figure-ground relationship influences the magnitude of brightness contrast. Lindauer & Lindauer (172) varied brightness differences and observed the effect on "vase-face" figure-ground patterns. The filled area was more likely to be seen as figure as the figure became darker. Spillmann & Levine (248) varied the figure-ground ratio in a Hermann grid pattern by systematic variation of the albedo of the simulus elements, resulting in specific facets of an optimum grid which showed maximum brightness changes at almost every intersection even when fixated foveally. These observations are in strong agreement with an analysis based on circular antagonistic retinal ganglion cell receptive fields,

SIZE AND DISTANCE

Three major publications appeared during the review period. Psychophysical Analysis of Visual Space, by Baird (14), summarizes the extensive literature and attempts to provide a metric for size and distance perception. The monograph *Human Space Perception: Proceedings of the Dartmouth Conference*, edited by

Baird (13), is a collection of essays by a number of contemporary researchers on size, distance, illusions, the theory of cues, stereoscopic vision, and the neurophysiology of space perception. *Foundations of Cyclopean Perception*, by Julesz (142), explores the rich variety of effects obtained with Julesz random-dot stereograms and attempts to increase our knowledge of many perceptual phenomena using stereograms as tools.

Size-distance invariance.—The concept of size-distance invariance continues to stimulate research. Gogel presented evidence that agrees with the size-distance invariance hypothesis and refutes previous studies which argue instead for the direct perception of retinal size (103). Using magnitude estimation, Teghtsoonian & Teghtsoonian (261) report that this method of quantification has methodological advantages and, in the present case, produced data which agree closely with size-distance invariance in a full cue situation. Also using magnitude estimation, Furedy & Stanley found that although the apparent size of afterimages follows physical (projection) distance, apparent distance did not (92). [For a critical comment on their methodology, see Teghtsoonian (260) as well as a rejoinder by the authors (93).] The results of Franklin, Ross & Weltman (90), whose observers viewed test objects underwater through a face mask, produced a negative correlation between size and distance adaptation. Their data suggest that divers adapt to one dimension while counteradapting to the other. The complexity of size and distance perception is further illustrated by Kuroda's (168) treatment of distance constancy. Not surprisingly, his quantitative relationships depended strongly on the observation conditions.

In a study which pays special attention to methodology, Weintraub & Gardner (278) review the distinction between two interpretations of Emmert's law, i.e. the law of retinal size which is a simple extension of optical geometry, and the principle of perceived size which is linked to the phenomenon of size constancy. As expected, the law of retinal size held with precision. However, data relating to the law of perceived size were influenced by a falsified cue, thus supporting the dual interpretations of Emmert's law and illustrating the necessity for methodological sophistication in this area of research. Although there is no doubt that the size-distance invariance hypothesis has stimulated much research, it is apparent that it is an oversimplication which can neither be meaningfully confirmed nor rejected in view of the many variables affecting size and distance judgments.

Mechanisms and models.—Humphrey & Weiskrantz (135) report that posterior partial lesions in monkeys produce no deficit in a size constancy task, while infereotemporal lesions caused a severe breakdown with almost no recovery. They hypothesize that the results are due to an inability to use both retinal size and distance information in computing physical size, and instead subjects use either retinal size or distance information alone. Richards (228, 230, 232) has suggested that stereopsis may depend on the activity of three classes of disparity detectors, crossed, zero, and uncrossed. Individual differences among observers would be related to a specific lack of a class of receptors. This position was stimulated by and is relevant to the problem of stereo blindness (228).

Methodological.—Gogel & Sturm (106) investigated the effectiveness of the relative size cue to distance as a function of directional separation and concluded that the use of large directional separations in the attempt to avoid the relative size cue is inappropriate. Similarly, Brislin & Leibowitz (35) determined that the size-distance function at various age levels is unaffected by the directional separation between the test and comparison objects. The role of verbal size information is illustrated by Coltheart (57), who reports that when the subject views a blank triangle under completely reduced conditions, any kind of information about size enables him to make a judgment of the distance. The role of such cognitive cues in size perception is also illustrated by Carlson & Tassone's (51) study using a familiar object, a human being, which they compared with a board of the same height and distance. They reported differences in perceived height and distance between the two test objects in agreement with the perspective attitude but not with size-distance invariance. In studying the role of accommodation and convergence as cues to distance, Wallach & Floor (275) report that size matches between figures of identical shape yielded poor results while matching two edges of the parts of different figures produced veridical results.

Wilcox & Teghtsoonian (287) applied operant techniques to the study of pictorial depth cues. The size illusion created by such cues was very effective for adults, moderately effective for 9-year-olds, and ineffective for 3-year-olds. These results are of interest not only methodologically but theoretically in relation to developmental and cross-cultural studies which typically use two-dimensional presentations to study the effective strength of learned monocular cues to depth.

Underwater environment.—Size and distance perception in the underwater environment provides a method for distorting spatial relationships and an opportunity to study the process of adaptation. Following up a study which demonstrated distortion of apparent distance underwater (205), Ono & O'Reilly studied adaptation to underwater distance distortion by varying the amount of feedback during the reaching response (206). The data from control subjects who simply observed others indicated no adaptation, results which are reminiscent of data from prism adaptation experiments. The amount of adaptation for the active subjects depended upon the sensory-motor task. Ross et al (233) also report adaptation to the underwater environment resulting from active handling of objects of known size. Experienced divers were more accurate than novices.

Results similar to data in the moon illusion literature were reported by Ross, King & Snowden (234) whose diver subjects made distance estimates for stimuli in different directions. The surface of the water overhead was underestimated to a greater extent than those below or in the horizontal plane.

Conclusion.—In general, the period under review has revealed little in the psychophysical literature on perception of size and distance that does not represent extensions, parametric analysis, or retesting of hypotheses and concepts from the previous literature. It may well be that the introduction of significant new methodologies, or identification of relevant physiological mechanisms is necessary before the apparent progress evident in other fields of perception will characterize this literature.

ILLUSIONS

The continuing attempt to understand the deceptively simple illusions continued unabated, with a steady output of about three papers per month during the 2-year period under review. The majority of these fall within a specific theoretical context. The heuristic assumption which has played a major energizing role among contemporary researchers, that illusions represent misplaced mechanisms appropriate to ordinary viewing, has been tested with respect to the Müller-Lyer illusion by Massaro & Anderson (182). They presented real depth cues in two orientations, and although substantial illusion was obtained, the differences between the orientations were small and opposite to a prediction based on misplaced perspective theory. A study of apparent size and depth relations in the Müller-Lyer illusion by Stacey & Pike (250) also contradicts specific predictions derived from misplaced size constancy theory, as does a series of experiments by Fisher (83). Application of the notion of depth processing proved more successful when applied to the Poggendorff illusion by Gillam (100), and also accounted for the effects of "amputations" and rotations of the Poggendorff figure by Weintraub & Krantz (279).

Day has extended the general constancy theory of illusions to a wide variety of illusory forms (68). He argues that when different classes of illusions are recognized, i.e. size, orientation, and movement, any stimulus that serves to maintain constancy will, when varied with an invariant retinal image, produce an illusion.

Consideration of visual illusion effects within the framework of adaptation level theory is illustrated by Restle (226) for judgment of line length in several geometric optical configurations. He concludes that this kind of theory has something to contribute to the study of illusions. In a later study concerned with judgment of line length under different instructions, Restle (225) demonstrated the applicability of the Helson equations while also establishing the importance of cognitive factors. The applicability of adaptation level theory was also demonstrated by Avant (11) in a study of contrast and assimilation effects in the Müller-Lyer illusion, and to the perceptual displacement of a test mark toward the larger of two objects by Merryman & Restle (190). A careful reader of this literature will note some overlap among these various theoretical positions. This is particularly true of N. H. Anderson's averaging model as applied to the size-weight illusion (4, 5) and to the Ebbinghaus illusion (183), which bears some similarity to adaptation level theory as well as to the "mixed model" approach of Hake et al (118) and of Weintraub (277). The impressive versatility of Gogel's adjacency principle (101) is demonstrated by its relevance to the Ames room and other Ames demonstrations and to the moon, Ponzo, and Zöllner illusions (102).

The application of sophisticated quantitative techniques which are relevant to a broad spectrum of psychological problems is most encouraging.

The ecological hypothesis, which could be considered to be a special case of the misapplied depth cue explanation, is supported by Jahoda & Stacey's study of susceptibility to illusions as a function of culture and professional training (137). Piaget's theory of *centration* provided the rationale for a study of the effect of stimulus size on the magnitude of the Ponzo illusion, but the results were negative (79).

Sensory factors.—Coren (61) eliminated the adjacent contours assumed by lateral inhibition theory to be responsible for the Poggendorff and Müller-Lyer illusions. The reduction in illusion magnitudes suggests that lateral inhibition may play a contributory role, but it is not the primary causal factor. Sjostrom & Pollack attempted to simulate aging by means of a yellow filter, and noted a decrease in the magnitude of the Delboeuf illusion but not of the Usnaze effect (242). Pollack determined the developmental function for Müller-Lyer figures produced by lightness contrast and by hue contrast, i.e. in the absence of lightness contrast. Contrary to expectations based on Piaget's theory, the illusion magnitudes for the colored figures did not decrease with age (219).

Although illusions, especially the simpler geometric-optical forms, may appear to be amenable to simplistic, unimechanistic explanations, the continuing evidence from experimental studies suggests strongly that a broad spectrum of psychological and physiological mechanisms is involved. Although some progress has been made, we are clearly a long way from the goal expressed by Boring in which illusions are understood as special cases of the general laws of perception. Alas, illusions are as complex as perception itself, and our failure to adequately explain them is a sobering evaluation of the contemporary state of the art.

REARRANGEMENT STUDIES

Mechanisms and models.—Graybiel & Held (113) found significant adaptation to prismatic displacement under both scotopic and photopic conditions. Although scotopic induced adaptation can be transferred under both scotopic and photopic conditions of testing, transfer of photopically induced adaptation is limited primarily to photopic test conditions. These results are of interest in relation to the evidence from visually induced self-rotation sensation experiments which suggest that input from the central and peripheral visual fields are processed differently by the central nervous system (73). The continuing controversy regarding the mechanism of adaptation to prism displacement was investigated by Hardt, Held & Steinbach (120), who compared the predictive value of four types of explanation: visual, proprioceptive, motor, and sensorimotor. The results of a series of experiments involving prism displaced images of the hand were consistent only with the sensorimotor explanation.

Wilkinson (289) analyzed prism adaptation with the assumption that the visual motor control loop is a linear system comprising a number of independent subsystems. The data on adaptation to visual motor discordancies produced by wedge prisms result in both a change in the judgment of visual direction of targets and a change in setting the hand to the median plane. The summation of these two effects is consistent with the theory in that the change in target aiming performance is equal to the sum of the individual components. The data obtained by viewing a visual display through the prisms, however, did not fit this linear model.

The continuing stimulus value of von Holst & Mittelsteadt's (130) reafference theory is evidenced by Moulden's study (199) in which subjects viewed a prismatically displaced image of their actively moved hand which was optically "stopped." As much adaptation was achieved under the stopped condition as with full reafferent stimulation. Adaptation to optical tilt by Ebenholtz & Redding (77) was consistent with derivations from a memory-comparator model of perceptual adaptation. Ebenholtz has analyzed the relation between interocular transfer of adaptation and Hering's law of equal innervation and concludes that failure to obtain complete transfer of adaptation implies either that the adaptation does not involve the oculo-motor system, e.g. specialized retinal-cortical cells, or some reflexive eye movement mechanism may be confounding the results (76).

Canon (47, 48) and Uhlarik & Canon (269) have presented data supporting Canon's model which is based on intermodality inconsistency. In Canon's experiments (47, 48) subjects were presented with conflicting auditory and visual cues and instructed to attend to only one modality. Post-exposure shifts were observed only for the modality not attended to. The absence of reafferent stimulation points to the role of informational inconsistency (276).

Parametric studies.—The modifiable parameter of eye-hand coordination and prism adaptation is found to be a displacement applying equally to all target positions (124). A magnification parameter was partially modified in that a wider range of hand movements became identified with a fixed eye movement range. Dewar reports a series of three studies. In the first (70) prism strength was varied under conditions of massed and distributed practice. While distributed practice led to a gradual increase in the aftereffect following prism exposure, massed practice produced a rapid decrease followed by a slight increase. In a study involving length of exposure and amount of optical distortion, extent of adaptation was, not unexpectedly, related to number of trials. However, a surprising adaptation (30%) was produced after only two trials (71). In general, adaptation was positively related to degree of optical displacement. In a "prismatic-shaping" study (72), Dewar reports that amount of adaptation and accuracy of target localization were directly related to the suddenness with which displacement was introduced.

Methodological.—The majority of experiments during this period are methodological and not readily classifiable on a systematic basis. An exception is a series of studies demonstrating that external stimuli present during exposure can serve as situational cues and in turn influence the magnitude of aftereffects manifested subsequent to adaptation. Uhlarik & Canon (268) report that aftereffects were greater when nondisplacing goggles were worn during the periods in which aftereffect measures were taken. Furthermore, manipulation of cues such as restriction of the visual field and weight of the goggles, associated with adaptation, can in part determine the size of the observed aftereffects. Similar results were reported by Welch (282), who demonstrated that adaptation to prism displacement can be conditioned to stimuli associated with the goggles in which the prisms were housed. Similarly, Kravitz (165) reports that tests involving pointing to the visual target and tests involving pointing straight ahead both produce more adaptation and more aftereffect of adaptation when goggles are worn during testing. Such results are of considerable interest both methodologically and theoretically.

By means of an electronic rearrangement technique, vertical motions of the head were made to cause diagonal optical motions by Hay (123). The constancy of visual position during head movement showed a rapid adaptive change, but no change was found in perceived movement direction when the head was held stationary and a vertical object movement presented. Hay concludes that a memory exists for the correlation between head motion and optical motion but that this memory does not control the perception of externally generated optical motions. The central field of view was rotated by Smothergill, Martin & Pick (244) by use of a closed circuit TV system. They report a developmental change in performance under large rotations, e.g. 180°, as well as evidence of a discontinuous breakdown angle. Further research on the breakdown angle produced individual differences among subjects. Epstein reports that the nature of the activity during the preadaptation period affects the magnitude of adaptation to a meridional size lens (78).

A methodological "twist" is provided by Foley, whose subjects wore a prism base down in front of one eye. The other eye viewed through either a base down prism (86) or plain glass (87). In both studies, luminance was varied systematically by positioning neutral density filters in front of one eye. With no filter and oppositely oriented prisms, the directional judgments of both eyes were dominated by the base down (upward displacing) prism. The effect of the filter depended upon the base orientation of the prism. With the base down-plain glass combination, no aftereffect could be measured when the luminance of the "normal" field was equal to or greater than the prism field. However, as the luminance of the normal field was decreased below that of the prism field, an effect was observed.

A novel adaptation arrangement was introduced by Mack & Chitayat (176), who induced opposite rotations in the two eyes. The results indicated simultaneous and opposite eye dependent changes in the monocular perception of the vertical, and adaptive changes in the perception of the stereovertical such that a depth response (in the saggital plane) was introduced by zero disparity. Since it is highly unlikely that unsophisticated observers could predict changes in depth resulting from "recalibration" of retinal disparities, this technique would be minimally influenced by subject expectations and demand characteristics.

SPECIAL TOPICS AND MISCELLANEOUS

A rather unusual "illusion" among aircraft pilots has been observed by Kraft & Elworth (164). When approaching a lighted city at night over a dark area, even experienced pilots considerably overestimate their altitude. This overestimation has been implicated as a major factor in a number of aircraft accidents and incidents, and its identification has led to effective corrective measures. Well-designed studies of problems arising from within an applied context can both contribute to our understanding of basic processes and, as in the present exemplary case, also produce data of immense practical importance.

Finally, the reviewers would like to call the readers' attention to a report by Weiskrantz, Elliot & Darlington entitled Preliminary Observations on Tickling Oneself (280). The authors are concerned with the readily observed phenomenon that we are ordinarily more successful at tickling others than tickling ourselves. This was confirmed statistically with the aid of a specially constructed "tickling apparatus" with which they compared the effects of tickles administered by the experimenter, the subject, and a third condition in which the subject's arm was moved passively by the experimenter. They concluded that cancellation of a self-administered tickle is most probably accomplished by a self-generated command signal but they are not certain as to the role of feedback. This study not only extends the generality of the reafference principle (130), but provides a striking demonstration of the applicability of experimental techniques to a familiar but hitherto unanalyzed phenomenon.

LITERATURE CITED

1. Aiken, L. S., Brown, D. R. 1971. Feature utilization of continuously varying attributes in visual pattern classification. *Percept. Psychophys.* 9:145–49
2. Ibid. A feature utilization analysis of the perception of pattern class structure, 279–83
3. Allen, M. J. 1970. *Vision and Highway Safety*. Philadelphia: Chilton. 253 pp.
4. Anderson, N. H. 1970. Averaging model applied to the size-weight illusion. *Percept. Psychophys.* 8:1–4
5. Anderson, N. H. 1971. Test of adaptation-level theory as an explanation of a recency effect in psychophysical integration. *J. Exp. Psychol.* 87:57–63
6. Anstis, S. M. 1970. Phi movement as a subtraction process. *Vision Res.* 10:1411–30
7. Anstis, S. M., Moulden, B. P. 1970. After effect of seen movement: Evidence for peripheral and central components. *Quart. J. Exp. Psychol.* 22:222–29
8. Appelle, S. 1972. Perception and discrimination as a function of stimulus orientation: The "oblique effect" in man and animals. *Psychol. Bull.* 78(4):266–78
9. Appley, M. H., Ed. 1971. *Adaptation Level Theory*. New York: Academic. 346 pp.
10. Arnheim, R. 1969. *Visual Thinking*. Berkeley: Univ. California Press. 348 pp.
11. Avant, L. L. 1971. Contrast and assimilation effects in judgments of line configurations containing the Mueller-Lyer figure. *Percept. Psychophys.* 10:437–41
12. Bagrash, F. M., Kerr, L. G., Thomas, J. P. 1971. Patterns of spatial integration in the detection of compound visual stimuli. *Vision Res.* 11:635–45
13. Baird, J. C. 1970. Human Space Perception: Proceedings of the Dartmouth Conference. *Psychon. Mon. Suppl.* 3:137–219
14. Baird, J. C. 1970. Psychophysical analysis of visual space. In *International Series of Monographs in Experimental Psychology*, ed. H. Eysenck. New York: Pergamon. 321 pp.
15. Barrett, T. W. 1969. The cortex as interferometer: The transmission of amplitude, frequency and phase in cortical structures. *Neuropsychologia* 7:135–48
16. Bayly, E. J., Cervetto, L., Fiorentini, A., Maffei, L. 1971. On and off retinal cells in parallel channel neural communication. *Kybernetik* 8:52–58
17. Beck, J. 1971. Surface lightness and cues for the illumination. *Am. J. Psychol.* 84: 1–11
18. Bernstein, A. S., Taylor, K., Austen, B. G., Nathanson, M., Scarpelli, A. 1971. Orienting response and apparent movement toward or away from the observer. *J. Exp. Psychol.* 87:37–45
19. Biederman-Thorson, M., Thorson, J., Lange, G. D. 1971. Apparent movement due to closely spaced sequentially flashed dots in the human peripheral field of vision. *Vision Res.* 11:889–903
20. Blake, R. R., Fox, R., McIntyre, C. 1971. Stochastic properties of stabilized-image binocular rivalry alternations. *J. Exp. Psychol.* 88: 327–32
21. Blakemore, C., Braddick, O., Gregory, R. L. 1970. Detailed texture of eidetic images: a discussion. *Nature* 226:1267–68
22. Blakemore, C., Campbell, F. W. 1969. On the existence of neurones in the human visual system selectively sensitive to the orientation and size of retinal images. *J. Physiol.* 203:237–60
23. Blakemore, C., Carpenter, R. H. S., Georgeson, M. A. 1970. Lateral inhibition between orientation detectors in the human visual system. *Nature* 228:37–39
24. Ibid 1971. Lateral thinking about lateral inhibition. 234:418–19
25. Blakemore, C., Muncey, J. P. J., Ridley, R. M. 1971. Perceptual fading of a stabilized cortical image. *Nature* 233:204–5
26. Blakemore, C., Nachmias, J. 1971. The orientation specificity of two visual after-effects. *J. Physiol.* 213: 157–74
27. Blakemore, C., Nachmias, J., Sutton, P. 1970. The perceived spatial frequency shift: Evidence for fre-

quency selective neurones in the human brain. *J. Physiol.* 210:727–50

28. Blakemore, C., Sutton, P. 1969. Size adaptation: A new aftereffect. *Science* 166:245–47
29. Bouma, H., Andriessen, J. J. 1970. Induced changes in the perceived orientation of line segments. *Vision Res.* 10:333–49
30. Bradshaw, J. L., McKenzie, B. E. 1971. Judging outline faces: A developmental study. *Child Develop.* 42:929–37
31. Bradshaw, J. L., Wallace, G. 1971. Models for the processing and identification of faces. *Percept. Psychophys.* 9:443–48
32. Brand, J. 1971. Classification without identification in visual search. *Quart. J. Exp. Psychol.* 23:178–86
33. Brandt, T., Wist, E., Dichgans, J. 1971. Optisch induzierte Pseudocoriolis-Effekte und Circularvektion. *Arch. Psychiat. Nervenkr.* 214:365–89
34. Braunstein, M. L. 1971. Perception of rotation in figures with rectangular and trapezoidal features. *J. Exp. Psychol.* 1:25–29
35. Brislin, R. W., Leibowitz, H. W. 1970. The effect of separation between test and comparison objects on size constancy at various age-levels. *Am. J. Psychol.* 83:372–76
36. Brown, B. R., Aylworth, C. E. 1970. Feature encoding and pattern classifications with sequentially presented Markov stimuli. *Percept. Psychophys.* 9:203–7
37. Brown, J. L. 1973. Visual sensitivity. *Ann. Rev. Psychol.* 24:151–86
38. Burns, B. D., Pritchard, R. 1971. Geometrical illusions and the response of neurones in the cat's visual cortex to angle patterns. *J. Physiol.* 213:599–616
39. Campbell, F. W., Cooper, G. F., Enroth-Cugell, C. 1969. The spatial selectivity of the visual cells of the cat. *J. Physiol.* 203:223–35
40. Campbell, F. W., Kulikowski, J. J. 1966. Orientational selectivity of the human visual system. *J. Physiol.* 187:437–45
41. Campbell, F. W., Kulikowski, J. J., Levinson, J. 1966. The effect of orientation on the visual resolution of gratings. *J. Physiol.* 187:427–36
42. Campbell, F. W., Maffei, L. 1970. Electrophysiological evidence for the existence of orientation and size detectors in the human visual system. *J. Physiol.* 207:635–52
43. Campbell, F. W., Maffei, L. 1971. The tilt after-effect: a fresh look. *Vision Res.* 11:833–40
44. Campbell, F. W., Nachmias, J., Jukes, J. 1970. Spatial-frequency discrimination in human vision. *J. Opt. Soc. Am.* 60:555–59
45. Campbell, F. W., Robson, J. G. 1959. High speed infra-red optometer. *J. Opt. Soc. Am.* 49:268–72
46. Campbell, F. W., Robson, J. G. 1968. Application of Fourier analysis to the visibility of gratings. *J. Physiol.* 197:551–66
47. Canon, L. K. 1970. Intermodality inconsistency of input and directed attention as determinants of the nature of adaptation. *J. Exp. Psychol.* 84:141–47
48. Ibid 1971. Directed attention and maladaptive "adaptation" to displacement of the visual field. 88:403–8
49. Cardu, B., Gilbert, M., Strobel, M. 1971. The influence of spatial intervals and thickness of lines of stimulus patterns on stabilized images. *Vision Res.* 11:671–77
50. Ibid. The influence of peripheral and central factors on the way stabilized images disappeared, 1337–43
51. Carlson, V. R., Tassone, E. P. 1971. Familiar versus unfamiliar size: a theoretical derivation and test. *J. Exp. Psychol.* 1:109–15
52. Carter, B. E., Henning, G. B. 1971. The detection of gratings in narrow-band visual noise. *J. Physiol.* 219:355–65
53. Chase, R., Kalil, R. 1972. Suppression of visual evoked responses to flashes and pattern shifts during voluntary saccades. *Vision Res.* 12:215–20
54. Cohen, G. 1970. Search times for combinations of visual, phonemic, and semantic targets in reading prose. *Percept. Psychophys.* 8:370–72
55. Cole, R. E., Diamond, A. L. 1971. Amount of surround and test-inducing separation in simultaneous brightness contrast. *Percept. Psycophys.* 9:125–28
56. Colegate, R. L., Eriksen, C. W. 1970. Implicit speech as an encoding

mechanism in visual perception. *Am. J. Psychol.* 83:208–15

57. Coltheart, M. 1970. The effect of verbal size information upon visual judgments of absolute distance. *Percept. Psychophys.* 9:222–23
58. Coltheart, M. 1971. Is there lateral inhibition in the visual cortex? *Nat. New Biol.* 231:256
59. Coltheart, M. 1971. Visual feature-analyzers and aftereffects of tilt and curvature. *Psychol. Rev.* 78: 114–21
60. Coren, S. 1969. Brightness contrast as a function of figure-ground relations. *J. Exp. Psychol.* 80:517–24
61. Coren, S. 1970. Lateral inhibition and geometric illusions. *Quart. J. Exp. Psychol.* 22:274–78
62. Coren, S. 1970. Lateral inhibition and the Wundt-Hering illusion. *Psychon. Sci.* 18:341
63. Cornsweet, T. N. 1970. *Visual Perception.* New York: Academic. 475 pp.
64. Cornsweet, T. N., Crane, H. D. 1970. Servo-controlled infrared optometer. *J. Opt. Soc. Am.* 60:555–58
65. Cosgrove, M. P., Schmidt, M. J., Fulgham, D. D., Brown, D. R. 1971. The dependent variable in stabilized retinal image studies. *Vision Res.* 11:1183–87
66. Cross, J. F., Cross, J., Daly, J. 1971. Sex, race, age, and beauty as factors in recognition of faces. *Percept. Psychophys.* 10:393–96
67. Davidson, M., Whiteside, J. A. 1971. Human brightness perception near sharp contours. *J. Opt. Soc. Am.* 61:530–36
68. Day, R. H. 1972. Visual spatial illusions: a general explanation. *Science* 175:1335–40
69. Day, R. H., Strelow, E. 1971. Reduction or disappearance of visual after-effect of movement in the absence of patterned surround. *Nature* 230:55–56
70. Dewar, R. 1970. Adaptation to displaced vision—the influence of distribution of practice on retention. *Percept. Psychophys.* 8:33–34
71. Ibid. Adaptation to displaced vision —amount of optical displacement and practice, 313–16
72. Ibid 1971. Adaptation to displaced vision: variations on the "prismatic-shaping" technique. 9:155–57
73. Dichgans, J., Brandt, T. 1972. Visual-vestibular interaction. In *Cerebral Control of Eye Movements and Motion Perception*, ed. J. Dichgans, E. Bizzi. New York: Karger
74. Dodwell, P. C. 1970. *Visual Pattern Recognition.* New York: Holt, Rinehart & Winston. 276 pp.
75. Duffy, F. H., Rengstorff, R. H. 1971. Ametropia measurements from the visual evoked response. *Am. J. Optom.* 48:717–28
76. Ebenholtz, S. M. 1970. On the relation between interocular transfer of adaptation and Hering's law of equal innervation. *Psychol. Rev.* 77 (4):343–47
77. Ebenholtz, S. M., Redding, G. M. 1970. Temporal characteristics of a comparator in adaptation to optical tilt. *Percept. Psychophys.* 7: 365–66
78. Epstein, W. 1971. Adaptation to uniocular image magnification after varying preadaptation activities. *Am. J. Psychol.* 84:66–74
79. Farquhar, M., Leibowitz, H. W. 1971. The magnitude of the Ponzo illusion as a function of age for large and for small stimulus configurations. *Psychon. Sci.* 25:97–99
80. Festinger, L., Coren, S., Rivers, G. 1970. The effect of attention on brightness contrast and assimilation. *Am. J. Psychol.* 83:189–207
81. Fidell, L. S. 1970. Orientation specificity in chromatic adaptation of human "edge-detectors." *Percept. Psychophys.* 8:235–37
82. Fisher, G. H. 1969. An experimental study of angular subtension. *Quart. J. Exp. Psychol.* 21:356–66
83. Ibid 1970. An experimental and theoretical appraisal of the perspective and size-constancy theories of illusions. 22:631–52
84. Flock, H. R. 1970. Jameson and Hurvich's theory of brightness contrast. *Percept. Psychophys.* 8: 118–24
85. Flock, H. R., Noguchi, K. 1970. An experimental test of Jameson and Hurvich's theory of brightness contrast. *Percept. Psychophys.* 8: 129–36
86. Foley, J. E. 1970. Prism adaptation with opposed base orientation: The weighting of direction information from the two eyes. *Percept. Psychophys.* 8:23–25
87. Ibid. Prism adaptation with simul-

taneous receipt of normal input. 393–95

88. Foster, D. H. 1971. A model of the human visual system in its response to certain classes of moving stimuli. *Kybernetik* 8:69–84
89. Foster, D. H. 1971. The response of the human visual system to moving spatially-periodic patterns: Further analysis. *Vision Res.* 11:57–81
90. Franklin, S. S., Ross, H. E., Weltman, G. 1970. Size-distance invariance in perceptual adaptation. *Psychon. Sci.* 21:229–31
91. Fukushima, K. 1970. A feature extractor for curvilinear patterns: A design suggested by the mammalian visual system. *Kybernetik* 7:153–60
92. Furedy, J. J., Stanley, G. 1970. The apparent size of "projected" afterimages under conditions where size-constancy holds. *Percept. Psychophys.* 7:165–68
93. Ibid 1971. More data and arguments for partial failure of Emmert's law under conditions of size constancy and veridical distance perception: Rejoinder to Teghtsoonian's comments. 10:99–100
94. Galper, R. E., Hochberg, J. 1971. Recognition memory for photographs of faces. *Am. J. Psychol.* 84:351–54
95. Garner, W. R. 1970. Good patterns have few alternatives. *Am. Sci.* 58:34–42
96. Gerrits, H. J. M., Timmerman, G. J. M. E. N. 1969. The filling-in process in patients with retinal scotomata. *Vision Res.* 9:439–42
97. Gerrits, H. J. M., Vendrik, A. J. H. 1970. Artificial movements of a stabilized image. *Vision Res.* 10: 1443–56
98. Gerrits, H. J. M., Vendrik, A. J. H. 1970. Simultaneous contrast, filling-in process and information processing in man's visual system. *Exp. Brain Res.* 11:411–30
99. Gilinsky, A. S., Mayo, T. H. 1971. Inhibitory effects of orientational adaptation. *J. Opt. Soc. Am.* 61: 1710–14
100. Gillam, B. 1971. A depth processing theory of the Poggendorff illusion. *Percept. Psychophys.* 10:211–16
101. Gogel, W. C. 1965. Equidistance tendency and its consequences. *Psychol. Bull.* 64:153–63
102. Gogel, W. C. 1970. The adjacency principle and three-dimensional visual illusions. In *Proc. Dartmouth Conf.*, ed. J. C. Baird, 153–69. *Psychon. Mon. Suppl.* 3:137–219
103. Gogel, W. C. 1971. The validity of the size-distance invariance hypothesis with cue reduction. *Percept. Psychophys.* 9:92–94
104. Gogel, W. C., Koslow, M. 1971. The effect of perceived distance on induced movement. *Percept. Psychophys.* 10:142–46
105. Gogel, W. C., Mershon, D. H. 1969. Depth adjacency and simultaneous contrast. *Percept. Psychophys,* 5: 13–17
106. Gogel, W. C., Strum, R. D. 1971. Directional separation and the size cue to distance. *Psychol. Forsch.* 35:57–80
107. Goldstein, A. G., Chance, J. E. 1970. Visual recognition memory for complex configurations. *Percept. Psychophys.* 9:237–41
108. Gould, J. D., Peeples, D. R. 1970. Eye movements during visual search and discrimination of meaningless, symbol, and object patterns. *J. Exp. Psychol.* 1:51–55
109. Graboi, D. 1971. Searching for targets: The effects of specific practice. *Percept. Psychophys.* 10:300–4
110. Graham, C. H., Gillam, B. J. 1970. Occurrence of theoretically correct responses during rotation of the Ames window. *Percept. Psychophys.* 8:257–60
111. Graham, N. 1972. Spatial frequency channels in the human visual system: Effects of luminance and pattern drift rate. *Vision Res.* 12:53–68
112. Graham, N., Nachmias, J. 1971. Detection of grating patterns containing two spatial frequencies: A comparison of single-channel and multiple-channel models. *Vision Res.* 11:251–59
113. Graybiel, A. M., Held, R. 1970. Prismatic adaptation under scotopic and photopic conditions. *J. Exp. Psychol.* 1:16–22
114. Gregory, A. H., Arnold, P. 1971. Fragmentation and closure in after-images. *Vision Res.* 11:1473–77
115. Gregory, R. L. 1966. *Eye and Brain.* New York: McGraw-Hill. 251 pp.
116. Gregory, R. L. 1970. *The Intelligent Eye.* New York: McGraw-Hill. 188 pp.

117. Grindley, G. C., Townsend, V. 1970. Visual search without eye movement. *Quart. J. Exp. Psychol.* 22:62–67

118. Hake, H. W., Faust, H. W., McIntyre, J. S., Murray, H. G. 1967. Relational perception and modes of perceiver operation. *Percept. Psychophys.* 2:469–78

119. Hamilton, C. R., Lund, J. S. 1970. Visual discrimination of movement: midbrain or forebrain? *Science* 170:1428–30

120. Hardt, M. E., Held, R., Steinbach, M. J. 1971. Adaptation to displaced vision—a change in the central control of sensorimotor coordination. *J. Exp. Psychol.* 89:229–39

121. Harter, M. R., White, C. T. 1968. Effects of contour sharpness and check size on visually evoked cortical potentials. *Vision Res.* 8:701–11

122. Harvey, L. O. Jr. 1971. Flicker sensitivity and retinal area. *J. Am. Opt. Assoc.* 42:653–57

123. Hay, J. C. 1971. Does head-movement feedback calibrate the perceived direction of optical motions? *Percept. Psychophys.* 10:286–88

124. Hay, J. C., Langdon, B., Pick, H. L. Jr. 1971. Spatial parameters of eye-hand adaptation to optical distortion. *J. Exp. Psychol.* 91:11–17

125. Held, R. 1970. Two modes of processing spatially distributed visual stimuli. In *The Neurosciences: Second Study Program*, ed. F. O. Schmidt. New York: Rockefeller Univ. Press

126. Held, R., Shattuck, S. R. 1971. Color- and edge-sensitive channels in the human visual system: Tuning for orientation. *Science* 174:314–16

127. Henderson, D. C. 1971. The relationships among time, distance, and intensity as determinants of motion discrimination. *Percept. Psychophys.* 10:313–20

128. Hennessy, R. T., Leibowitz, H. W. 1970. Subjective measurement of accommodation with laser light. *J. Opt. Soc. Am.* 60:1700–1

129. Hershberger, W. A., Urban, D. 1970. Three motion-parallax cues in one-dimensional polar projections of rotation in depth. *J. Exp. Psychol.* 3:380–83

130. Holst, E. von, Mittelstaedt, H. 1950. Das Reafferenzprinzip Wechselwirkungen zwischen zentralnervensystem und Peripherie. *Naturwissenschaften* 37:463–76

131. Horrel, R. I. 1971. The angle of intersection of contours as the determinant of a geometric illusion. *Percept. Psychophys.* 10:208–10

132. Hubel, D. H., Wiesel, T. N. 1959. Receptive fields of single neurones in the cat's striate cortex. *J. Physiol.* 148:574–91

133. Ibid 1962. Receptive fields, binocular interaction and functional architecture in the cat's visual cortex. 160:106–54

134. Ibid 1968. Receptive fields and functional architecture of monkey striate cortex. 195:215–43

135. Humphrey, N. K., Wieskrantz, L. 1969. Size constancy in monkeys with inferotemporal lesions. *Quart. J. Exp. Psychol.* 21:225–38

136. Ingle, D. J., Schneider, G. E. 1970. Brain mechanisms and vision: subcortical systems. *Science* 168:1493–94

137. Jahoda, G., Stacey, B. 1970. Susceptibility to geometrical illusions according to culture and professional training. *Percept. Psychophys.* 7:179–84

138. Jameson, D., Hurvich, L. M. 1970. Improvable, yes; insoluble, no: a reply to Flock. *Percept. Psychophys.* 8:125–28

139. Jardine, C. J., Jardine, N. 1971. The matching of parts of things. *Studia Logica* 27:123–32

140. Jardine, N. 1971. A new approach to pattern recognition. *Nature* 234:526–28

141. Jardine, N., van Rijsbergen, C. J. 1971. The use of hierarchic clustering in information retrieval. *Inform. Stor. Retrieval* 7:217–40

142. Julesz, B. 1971. *Foundations of Cyclopean Perception.* Univ. Chicago Press. 405 pp.

143. Kahneman, D., Wolman, R. E. 1970. Stroboscopic motion: effects of duration and interval. *Percept. Psychophys.* 8:161–64

144. Kaiser, P. K. 1971. Minimally distinct border as a preferred psychophysical criterion in visual hetero-

chromatic photometry. *J. Opt. Soc. Am.* 61:966–71

145. Kaiser, P. K., Greenspon, T. S. 1971. Brightness difference and its relation to the distinctness of a border. *J. Opt. Soc. Am.* 61:962–65
146. Kano, C. 1970. Changes of threshold of continuous visual movement by variation of phenomenal size—with invariant retinal size. *Psychol. Forsch.* 33:242–53
147. Kaufman, H., Levy, R. M. 1971. Analysis of the combination of perceptual dimensions. *Psychol. Bull.* 75:369–78
148. Kaufman, L., Cyrulnik, I., Kaplowitz, J., Melnick, G., Stoff, D. 1971. The complementarity of apparent and real motion. *Psychol. Forsch.* 34:343–48
149. Keesey, U. T. 1971. Comparison of human visual cortical potentials evoked by stabilized and unstabilized targets. *Vision Res.* 11:657–70
150. Kelly, D. H. 1971. Theory of flicker and transient responses, I. uniform fields. *J. Opt. Soc. Am.* 61:537–46
151. Ibid. Theory of flicker and transient responses, II. counterphase gratings, 632–40
152. Kennard, D. W., Hartmann, R. W., Kraft, D. P., Boshes, B. 1970. Perceptual suppression of afterimages. *Vision Res.* 10:575–85
153. Kinchla, R. A. 1971. Visual movement perception: a comparison of absolute and relative movement discrimination. *Percept. Psychophys.* 9:165–71
154. Kinchla, R. A., Allan, L. G. 1970. Visual movement perception: a comparison of sensitivity to vertical and horizontal movement. *Percept. Psychophys.* 8:399–405
155. Kling. J. W., Riggs, L. A., Eds. 1971. *Woodworth and Schlosberg's Experimental Psychology*, 591–94. New York: Holt. 1279 pp.
156. Knoll, H. A. 1966. Measuring ametropia with a gas laser. *Am. J. Optom.* 43:415–18
157. Knoll, H. A. 1972. The ophthalmetron. *J. Am. Optom. Assoc.* 43:73–77
158. Koenderink, J. J., van de Grind, W. A., Bouman, M. A. 1970. Models of retinal signal processing at high luminances. *Kybernetik* 6:227–37
159. Ibid 1971. Foveal information processing at photopic luminances. 8:128–44
160. Kolehmainen, K., Tuomisaari, R. 1969. The locus of visual afterimages. *Scand. J. Psychol.* 10:45–48
161. Kolers, P. A., Pomerantz, J. R. 1971. Figural changes in apparent motion. *J. Exp. Psychol.* 87:99–108
162. Kornfeld, G. H., Lawson, W. R. 1971. Visual-perception models. *J. Opt. Soc. Am.* 61:811–20
163. Kozaki, T. 1970. Effect of background lightness on contrast and assimilation. *Jap. Psychol. Res.* 12:75–81
164. Kraft, C. L. 1969. Measurement of height and distance information provided pilots by the extra-cockpit visual scene. In *Visual Factors in Transportation Systems, Proc. Spring Meet. NAS-NRC Comm. Vision*, 84–101. Washington, D. C.: Nat. Acad. Sci. Nat. Res. Counc.
165. Kravitz, J. H. 1972. Conditioned adaptation to prismatic displacement. *Percept. Psychophys.* 11:38–42
166. Krueger, L. E. 1970. Search time in a redundant visual display. *J. Exp. Psychol.* 83:391–99
167. Ibid. Effect of frequency of display on speed of visual search. 84:495–98
168. Kuroda, T. 1971. Distance constancy: Functional relationships between apparent distance and physical distance. *Psychol. Forsch.* 34:199–219
169. Lederberg, V. 1970. Color recognition during voluntary saccades. *J. Opt. Soc. Am.* 60:835–841
170. Leeuwenberg. E. L. J. 1971. A perceptual coding language for visual and auditory patterns. *Am. J. Psychol.* 84:307–50
171. Lie, I. 1971. Depth adjacency and whiteness contrast. *Scand. J. Psychol.* 12:303–4
172. Lindauer, M. S., Lindauer, J. G. 1970. Brightness differences and the perception of figure-ground. *J. Exp. Psychol.* 84:291–95
173. Lockhead, G. R. 1970. Identification and the form of multidimensional discrimination space. *J. Exp. Psychol.* 85:1–10
174. Ludlam, W. M., Cohen, S., Ludlam, D. P. 1970. The visual evoked re-

sponse: A new tool in vision research. *Am. J. Optom.* 47:505–19

175. Mack, A. 1970. An investigation of the relationship between eye and retinal image movement in the perception of movement. *Percept. Psychophys.* 8:291–98
176. Mack, A., Chitayat, D. 1970. Eye dependent and disparity adaptations to opposite visual field rotation. *Am. J. Psychol.* 83:352–71
177. MacKay, D. M. 1970. Elevation of visual threshold by displacement of retinal image. *Nature* 225:90–92
178. Ibid. Interocular transfer of suppressive effects of retinal image displacement, 872–73
179. MacKinnon, G. E. 1971. Steadily fixated figures and prolonged afterimages: Further evidence that fragmentation occurs nonrandomly. *Can. J. Psychol./Rev. Can. Psychol.* 25:384–94
180. MacKinnon, G. E., Forde, J., Piggins, D. J. 1969. Stabilized images, steadily fixated figures, and prolonged after-images. *Can. J. Psychol./Rev. Can. Psychol.* 23:184–95
181. Maffei, L., Campbell, F. W. 1970. Neurophysiological localization of the vertical and horizontal visual coordinates in man. *Science* 167:386–87
182. Massaro, D. W., Anderson, N. H. 1970. A test of a perspective theory of geometrical illusions. *Am. J. Psychol.* 83:567–75
183. Massaro, D. W., Anderson, N. H. 1971. Judgmental model of the Ebbinghaus illusion. *J. Exp. Psychol.* 89:147–51
184. Matthews, M. L. 1970. A study of afterimages generated by monocular and dichoptic viewing. *Percept. Psychophys.* 9:225–26
185. Mavrides, C. M. 1971. Clarification: Roles of predictors of discrimination latency with visual patterns. *Percept. Mot. Skills* 32:986
186. Ibid. Form perception: dimensions of pattern reproduction. 33:767–73
187. Ibid. Gestalt variables and feature measures as predictors of discrimination latency for polygon patterns, 919–25
188. Mavrides, C. M., Brown, D. R. 1970. Schematic concept formation: Feature measures and constraint redundancy as predictors. *Percept. Psychophys.* 7:239–43
189. McCollough, C. 1965. Color adaptation of edge-detectors in the human visual system. *Science* 149:1115–16
190. Merryman, C. T., Restle, F. 1970. Perceptual displacement of a test mark toward the larger of two visual objects. *J. Exp. Psychol.* 84:311–18
191. Mershon, D. H. 1971. Evidence for the relationship of depth adjacency to contrast. *Scand. J. Psychol.* 12:295–302
192. Mershon, D. H., Gogel, W. C. 1970. Effect of stereoscopic cues on perceived whiteness. *Am. J. Psychol.* 83:55–67
193. Michalewski, H. J. 1970. Flash-induced stabilized images. *Psychon. Sci.* 21:237–39
194. Millodot, M., Riggs, L. A. 1970. Refraction determined electrophysiologically. *Arch. Ophthalmol.* 84:272–78
195. Mitrani, L., Mateeff, St., Yakimoff, N. 1970. Smearing of the retinal image during voluntary saccadic eye movements. *Vision Res.* 10:405–9
196. Ibid. Temporal and spatial characteristics of visual suppression during voluntary saccadic eye movement, 417–22
197. Ibid 1971. Is saccadic suppression really saccadic? 11:1157–61
198. Mitrani, L., Yakimoff, N., Mateeff, St. 1970. Dependence of visual suppression on the angular size of voluntary saccadic eye movements. *Vision Res.* 10:411–15
199. Moulden, B. 1971. Adaptation to displaced vision: Reafference is a special case of the cue-discrepancy hypothesis. *Quart. J. Exp. Psychol.* 23:113–17
200. Noda, H., Freeman, R. B., Gies, B., Creutzfeldt, O. D. 1971. Neuronal responses in the visual cortex of awake cats to stationary and moving targets. *Exp. Brain Res.* 12:389–405
201. Noguchi, K., Masuda, N. 1971. Brightness changes in a complex field with changing illumination: A re-examination of Jameson and Hurvich's study of brightness constancy. *Jap. Psychol. Res.* 13:60–69
202. Noton, D., Stark, L. 1971. Scanpaths in eye movements during pattern perception. *Science* 171:308–11
203. Noton, D., Stark, L. 1971. Scan-

paths in saccadic eye movements while viewing and recognizing patterns. *Vision Res.* 11:929–42

204. Olson, R. K., Attneave, F. 1970. What variables produce similarity grouping? *Am. J. Psychol.* 83:1–21
205. Ono, H., O'Reilly, J. P. 1971. Adaptation to underwater distance distortion as a function of different sensory-motor tasks. *Hum. Factors* 13:133–39
206. Ono, H., O'Reilly, J. P., Herman, L. M. 1970. Underwater distance distortion within the manual work space. *Hum. Factors* 12:473–80
207. Over, R. 1971. Comparison of normalization theory and neural enhancement explanation of negative aftereffects. *Psychol. Bull.* 75:225–43
208. Owen, D. H., Andolsek, M. A. 1970. Form recognition: Individual strategies in multivariate cue utilization. *Percept. Psychophys.* 7:234–38
209. Owen, D. H., Brown, D. R. 1970. Visual and tactual form complexity: A psychophysical approach to perceptual equivalence. *Percept. Psycophys.* 7:225–28
210. Ibid. Visual and tactual form discrimination: Psychophysical comparison within and between modalities, 302–6
211. Owen, D. H., Chalfant, C. 1970. Central integration effects with stabilized afterimages. *Percept. Psychophys.* 7:284–86
212. Oyama, T. 1970. The visually perceived velocity as a function of aperture size, stripe size, luminance, and motion direction. *Jap. Psychol. Res.* 12:163–71
213. Pantle, A. 1970. Adaptation to pattern spatial frequency: Effects on visual movement sensitivity in humans. *J. Opt. Soc. Am.* 60:1120–24
214. Pearce, D. G., Porter, E. 1970. Changes in visual sensitivity associated with voluntary saccades. *Psychon. Sci.* 19:225–27
215. Piggins, D. J. 1969. Visual afterimages: Central and peripheral effects. *Scand. J. Psychol.* 10:287–88
216. Piggins, D. J. 1970. Fragmentation of a geometrical figure viewed under intermittent illumination. *Nature* 227:730–31
217. Pirenne, M. H. 1970. *Optics, Painting, and Photography.* England: Cambridge Univ. Press. 199 pp.
218. Pitts, D. G. 1972. Optometric techniques for the 70's. *J. Am. Optom. Assoc.* 43:64–72
219. Pollack, R. H. 1970. Mueller-Lyer illusion: Effect of age, lightness contrast, and hue. *Science* 170:93–95
220. Pollehn, H., Roehrig, H. 1970. Effect of noise on the modulation transfer function of the visual channel. *J. Opt. Soc. Am.* 60:842–48
221. Pollen, D. A., Lee, J. R., Taylor, J. H. 1971. How does the striate cortex begin the reconstruction of the visual world? *Science* 173:74–77
222. Pribram, K. H. 1971. *Languages of the Brain.* Englewood Cliffs, N. J.: Prentice Hall. 432 pp.
223. Price, R. H., Slive, A. B. 1970. Verbal processes in shape recognition. *J. Exp. Psychol.* 83:373–79
224. Rankin, W. C., Markley, R. P., Evans, S. H. 1970. Pythagorean distance and the judged similarity of schematic stimuli. *Percept. Psychophys.* 7:103–7
225. Restle, F. 1971. Instructions and the magnitude of an illusion: Cognitive factors in the frame of reference. *Percept. Psychophys.* 9:31–32
226. Restle, F. 1971. Visual illusions. See Ref. 9, 55–69
227. Richards, W. 1969. Saccadic suppression. *J. Opt. Soc. Am.* 59:617–23
228. Richards, W. 1970. Stereopsis and stereoblindness. *Exp. Brain Res.* 10:380–88
229. Richards, W. 1970. Color shifts following rapid eye movements. *J. Exp. Psychol.* 84:399–403
230. Richards, W. 1971. Anomalous stereoscopic depth perception. *J. Opt. Soc. Am.* 61:410–14
231. Richards, W. 1971. Motion detection in man and other animals. *Brain Behav. Evol.* 4:162–81
232. Richards, W. 1971. Size-distance transformations. In *Pattern Recognition in Biological and Technical Systems,* 276–87. Heidelberg: Springer Verlag
233. Ross, H. E., Franklin, S. S., Weltman, G., Lennie, P. 1970. Adaptation of divers to size distortion un-

der water. *Brit. J. Psychol.* 61:365–73

234. Ross, H. E., King, S. R., Snowden, H. 1970. Size and distance judgments in the vertical plane under water. *Psychol. Forsch.* 33:155–64

235. Sachs, M. B., Nachmias, J., Robson, J. G. 1971. Spatial-frequency channels in human vision. *J. Opt. Soc. Am.* 61:1176–86

236. Schmidt, M. J., Fulgham, D. D., Brown, D. R. 1971. Stabilized images: the search for pattern elements. *Percept. Psychophys.* 10: 295–99

237. Segal, S. J., Fusella, V. 1969. Effects of imaging on signal-to-noise ratio, with varying signal conditions. *Brit. J. Psychol.* 60:459–64

238. Segal, S. J., Fusella, V. 1970. Influence of imaged pictures and sounds on detection of visual and auditory signals. *J. Exp. Psychol.* 83:458–64

239. Sekuler, R., Lehr, D., Stone, W., Wolf, M. 1971. Human visual motion sensitivity: Evidence against a ratio theory of sensory coding. *Percept. Psychophys.* 9:483–84

240. Semmelroth, C. C. 1970. Prediction of lightness and brightness on different backgrounds. *J. Opt. Soc. Am.* 60:1685–89

241. Shepard, R. N., Metzler, J. 1971. Mental rotation of three-dimensional objects. *Science* 171:701–5

242. Sjostrom, K. P., Pollack, R. H. 1971. The effect of simulated receptor aging on two types of visual illusions. *Psychon. Sci.* 23:147–48

243. Smith, E. E., Nielsen, G. D. 1970. Representations and retrieval processes in short-term memory: Recognition and recall of faces. *J. Exp. Psychol.* 85:397–405

244. Smothergill, D. W., Martin, R., Pick, H. L. Jr. 1971. Perceptual-motor performance under rotation of the central field. *J. Exp. Psychol.* 87: 64–70

245. Snodgrass, J. G. 1971. Objective and subjective complexity measures for a new population of patterns. *Percept. Psychophys.* 10:217–24

246. Sperling, G. 1970. Model of visual adaptation and contrast detection. *Percept. Psychophys.* 8:143–57

247. Sperling, G., Budiansky, J., Spivak, J. G., Johnson, C. M. 1971. Extremely rapid visual search: The maximum rate of scanning letters for the presence of a numeral. *Science* 174:307–11

248. Spillmann, L., Levine, J. 1971. Contrast enhancement in a Hermann grid with variable figure-ground ratio. *Exp. Brain Res.* 13:547–59

249. Spitz, H. H. 1971. Scanpaths and pattern recognition. *Science* 173: 753

250. Stacey, B., Pike, R. 1970. Apparent size, apparent depth and the Müller-Lyer illusion. *Percept. Psychophys.* 7:125–28

251. Stark, L., Noton, D. 1971. Reply to Spitz, H. H. Scanpaths and pattern recognition. *Science* 173:753

252. Stone, G. C. 1971. Response latencies in visual search involving redundant or irrelevant information. *Percept. Psychophys.* 9:9–14

253. Strelow, E. R., Day, R. H. 1971. After effect of visual movement: Storage in the absence of a patterned surround. *Percept. Psychophys.* 9:485–86

254. Stromeyer, C. F. 1969. Further studies of the McCullough effect. *Percept. Psychophys.* 6:105–10

255. Stromeyer, C. F., Mansfield, R. J. W. 1970. Colored aftereffects produced with moving edges. *Percept. Psychophys.* 7:108–14

256. Stromeyer, C. F., Psotka, J. 1970. The detailed texture of eidetic images. *Nature* 225:346–49

257. Sullivan, G. D., Georgeson, M. A., Oatley, K. 1972. Channels for spatial frequency selection and the detection of single bars by the human visual system. *Vision Res.* 12:383–94

258. Sumi, S. 1971. The apparent displacement of a moving light spot. *Psychol. Forsch.* 34:349–60

259. Tanaka, Y., Nakajima, Y. 1970. Perception of moving figures 1, on the reduction phenomena. *Jap. Psychol. Res.* 12:172–75

260. Teghtsoonian, M. 1971. A comment on "the apparent size of 'projected' afterimages under conditions where size-constancy holds." *Percept. Psychophys.* 10:98

261. Teghtsoonian, R., Teghtsoonian, M. 1970. The effects of size and distance on magnitude estimations of apparent size. *Am. J. Psychol.* 83: 601–12

262. Thomas, E. A. C., Legge, D. 1970. Probability matching as a basis for

detection and recognition decisions. *Psychol. Rev.* 77:65–72

263. Thomas, J. P. 1970. Model of the function of receptive fields in human vision. *Psychol. Rev.* 77: 121–34
264. Thomas, J. P., Kerr, L. G. 1971. Evidence of role of size-tuned mechanisms in increment threshold task. *Vision Res.* 11:647–55
265. Townsend, J. T. 1971. A note on the identifiability of parallel and serial processes. *Percept. Psychophys.* 10:161–63
266. Tzavaras, A., Hécaen, H., LeBras, H. 1970. Le problème de la spécificité du déficit de la reconnaissance du visage humain lors des lésions hémisphériques unilatérales. *Neuropsychologia* 8:403–16
267. Ibid 1971. Troubles de la reconnaissance du visage humain et latéralisation hémisphérique lésionnelle chez les sujets gauchers. 9:475–77
268. Uhlarik, J. J., Canon, L. K. 1970. Effects of situational cues on prism-induced aftereffects. *Percept. Psychophys.* 7:348–50
269. Uhlarik, J. J., Canon, L. K. 1971. Influence of concurrent and terminal exposure conditions on the nature of perceptual adaptation. *J. Exp. Psychol.* 91:233–39
270. van de Geer, J. P. 1971. *Introduction to Multivariate Analysis for the Social Sciences.* San Francisco: Freeman
271. van de Grind, W. A., Koenderink, J. J., Landman, H. A. A., Bouman, M. A. 1971. The concepts of scaling and refractoriness in psychophysical theories of vision. *Kybernetik* 8:105–22
272. van Heerden, P. J. 1970. Models for the brain. *Nature* 225:177–78
273. Virsu, V. 1971. Tendencies to eye movement, and misperception of curvature, direction, and length. *Percept. Psychophys.* 9:65–72
274. Vitz, P. C., Todd, T. C. 1971. A model of the perception of simple geometric figures. *Psychol. Rev.* 78:207–28
275. Wallach, H., Floor, L. 1971. The use of size matching to demonstrate the effectiveness of accommodation and convergence as cues for distance. *Percept. Psychophys.* 10:423–28
276. Wallach, H., Kravitz, J. H., Lindauer, J. 1963. A passive condition for rapid adaptation to displaced visual direction. *Am. J. Psychol.* 76:568–78
277. Weintraub, D. J. 1971. Rectangle discriminability: perceptual relativity and the law of Prägnanz. *J. Exp. Psychol.* 88:1–11
278. Weintraub, D. J., Gardner, G. T. 1970. Emmert's laws: size constancy vs. optical geometry. *Am. J. Psychol.* 83:40–51
279. Weintraub, D. J., Krantz, D. H. 1971. The Poggendorff illusion: amputations, rotations, and other perturbations. *Percept. Psychophys.* 10:257–64
280. Weiskrantz, L., Elliott, J., Darlington, C. 1971. Preliminary observations on tickling oneself. *Nature* 230:598–99
281. Weisstein, N. 1969. What the frog's eye tells the human brain: single cell analyzers in the human visual system. *Psychol. Bull.* 72:157–76
282. Welch, R. B. 1971. Discriminative conditioning of prism adaptation. *Percept. Psychophys.* 10:90–92
283. Westlake, P. R. 1970. The possibilities of neural holographic processes within the brain. *Kybernetik* 7:129–53
284. White, C. T., Bonelli, L. 1970. Binocular summation in the evoked potential as a function of image quality. *Am. J. Optom.* 47:304–9
285. White, K. G. 1971. Zöllner illusion as perceptual enlargement of acute angle. *Psychon. Sci.* 24:73–74
286. Whiteside, J. A., Davidson, M. L. 1971. Symmetrical appearance of bright and dark Mach bands from an exponential illumination gradient. *J. Opt. Soc. Am.* 61:958–61
287. Wilcox, B. L., Teghtsoonian, M. 1971. The control of relative size by pictorial depth dues in children and adults. *J. Exp. Child Psychol.* 11:413–29
288. Wildt, G. J. van der, Bouman, M. A. 1971. An accommodometer: an apparatus for measuring the total accommodation response of the human eye. *Appl. Opt.* 6:1950–58
289. Wilkinson, D. A. 1971. Visual-motor control loop: a linear system. *J. Exp. Psychol.* 89:250–57
290. Willshaw, D. J., Longuet-Higgins, H. C., Buneman, O. P. 1970. Reply to van Heerden. *Nature* 225:178

291. Woodworth, R. S. 1939. *Experimental Psychology*, 591–95. New York: Holt. 880 pp.
292. Yasuda, M. 1971. A dynamic model of the vertebrate retina. *Kybernetik* 9:26–30
293. Yin, R. K. 1970. Face recognition by brain-injured patients: a dissociable ability. *Neuropsychologia* 8: 395–402
294. Young, F. A., Lindsley, D. B., Eds. 1970. *Early Experience and Visual Information Processing in Perceptual and Reading Disorders. Proceedings* 839. Washington, D. C.: Nat. Acad. Sci. 533 pp.
295. Zaciu, R. C., Buzuloiu, V. 1970. Model of retinal receptive fields. *J. Opt. Soc. Am.* 60:1528–30
296. Zusne, L. 1970. *Visual Perception of Form*. New York: Academic. 547 pp.

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MEASUREMENT OF PERSONALITY TRAITS: THEORY AND TECHNIQUE[1]

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Previous volumes of the *Annual Review of Psychology* have on occasion included a chapter on the general subject of personality assessment. In the last review of this subject area, Fiske & Pearson (151) dropped the term "assessment" and replaced it with "measurement." We believe that both assessment of personality and measurement of personality are inaccurate and misleading. We do not measure personality; we measure traits which, hopefully, provide information about some of the relevant dimensions of personality.

Our review covers the literature from approximately July 1968 through July 1971. During this period a very large number of articles have been published which are in one way or another relevant to the measurement of personality traits. Our review, obviously, must be limited. Those articles dealing with the measurement of personality traits by projective techniques are not reviewed; we have more or less limited our coverage, with but few exceptions, to the measurement of personality traits by means of scales and inventories.

Books, Reviews, and Bibliographies

A number of books have been published which deal with the measurement of personality traits. Edwards' (120) text is statistical and methodological and the coverage is limited to scales and inventories. An appendix, which may be useful to research workers, contains the social desirability scale values of the items in the Edwards Personality Inventory, the Personality Research Form AA, the California Psychological Inventory, the Edwards Personal Preference Schedule, and the Minnesota Multiphasic Personality Inventory, along with the proportion of students responding True to the items.

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[1] For supplementary bibliographic material (106 references, 11 pages), order NAPS Document 01862 from ASIS, c/o Microfiche Publications, 305 East 46th St., New York, NY 10017. Remit in advance for each NAPS accession number $1.50 for microfiche or $5.00 for each photocopy (15¢ for each additional page over 30). Make checks payable to microfiche Publications.

[2] The preparation of this review was assisted in part by Research Grant MH-04075 from the National Institute of Mental Health, United States Public Health Service, Allen L. Edwards, Principal Investigator.

Fiske's (150) book is a well-reasoned presentation of the problems involved in measuring the concepts of personality. Both the Fiske and Edwards books are intended for upper division and graduate students. At a more elementary level is the text by Lanyon & Goodstein (261) which is supplemented at a more advanced level by a book of readings (173).

Other books of interest which deal with the measurement of personality traits are those by Cattell & Warburton (65), Eysenck & Eysenck (138), Pervin (334), Vernon (415), Mischel (309), and Holt (212).

A number of critical reviews and articles have been published which should be of interest to the readers of this chapter. Vacchiano, Strauss & Hochman (412) have provided a general review of research on dogmatism and Ehrlich & Lee (129) a more specialized review of dogmatism in relation to learning and resistance to change. Saltz (359) has proposed a reconceptualization of the results of experimental research with the Manifest Anxiety scale, and Wine (439) has suggested an attentional interpretation of the effects of test anxiety on performance.

Heise (198) has presented a critical review of methodological issues relating to research with the semantic differential, and Cronbach & Furby (84) have criticized various proposed measures of change. Studies involving measures of affiliation and the related area of conformity have been reviewed by Mehrabian & Ksionzky (299). An excellent and detailed review of the measurement and methodological problems involved in the use of projective techniques as assessment devices in personality research has been provided by Sechrest (371).

Schultz' (364) critical discussion of the human subject in psychological studies is particularly relevant to personality research as is also Carlson's (57) review which raises the question of where the person is in personality research. A related review is that by Stricker, Messick & Jackson (401) on studies involving deception of subjects and of the problems involved through the use of this tactic.

Scott (370) has reviewed a number of studies involving the comparative validities of forced-choice and single-stimulus scales and reports on an empirical study of his own. He concludes that at the present time the most tenable conclusion is that the evidence does not support the superiority of either type of item format. Hicks (201), in his review of forced-choice and normative scales, arrives at the same conclusion.

Buros (51) has published, in a separate volume, the reviews and bibliographies of various personality inventories contained in the first six Mental Measurement Yearbooks. This should prove to be a most welcome and convenient reference for anyone interested in the measurement of personality traits. The new volume also includes a considerable amount of new material. A useful supplement to Buros' book is a historical survey of personality scales and inventories by Goldberg (168).

Joe (237) has reviewed the literature on locus of control as a personality variable, and Throop & MacDonald (407) have published a bibliography on this construct. Another bibliography of interest is one on Q technique by Brown (48).

INVENTORIES

The Minnesota Multiphasic Personality Inventory (*MMPI*).—Damarin (91), in a review of Buros (51), reported, not unexpectedly, that the MMPI has been the most frequently used personality inventory. Although MMPI clinical scales were originally developed empirically to differentiate diagnostic groups from a control, the specific scales frequently fail to do so in cross-validation studies (190). During the period under review, MMPI scales (or items) have been used in attempts to differentiate various other criterion groups from a control including: patients with hallucinations (271), drug addicts (275), sociopaths (97), smokers (19, 103), alcoholics (169, 180, 410), conscientious objectors (295), and academically gifted women college students (143).

Attempts have also been made to differentiate between brain-damaged and schizophrenic patients (411, 430), and physical and social science students (251). Other groups studied with the MMPI include private hospital patients (27), nurses (146), and college freshmen (155).

Correlations have been reported between various MMPI scales and such variables as taste blindness (416), termination of youth counseling (214), age, education, and intelligence (408), menstrual irregularity (191), responses to cartoons (209), perseverance in a convent (259), job success of hospital aides (291), and Negro acculturation in a northern city (197).

Scores on MMPI scales have been found to be correlated with various other scales including the Willingness to Accept Limitations Scale (273), extraversion-introversion (24, 175), locus of control (50), and scales based on the Interpersonal Check List (292). Investigations of the construct validity of MMPI scales have employed interviewer ratings (196), self ratings (184), and ideal-self responding (203).

Conger (77) found that a dimensional analysis of 100 selected MMPI items replicated the two major MMPI factors obtained when correlations between MMPI scales are factor analyzed. Lorr (276), using 77 selected MMPI items, was able to replicate five of the seven factors previously defined by Tryon (409) from a cluster analysis of MMPI items. It has been shown, however, that when scores on the seven Tryon cluster scales are intercorrelated and factor analyzed, the usual two major MMPI factors are obtained (124, 128).

Kincannon (244) selected 71 items as representative of the content of MMPI scales to develop what he has called the Mini-Mult. Lacks & Powell (257) and Lacks (256) report correlations between scales scored on the Mini-Mult and on the MMPI that agree with those obtained by Kincannon. Other studies (5, 6) report, however, that Mini-Mult profiles for individual subjects permit few conclusions regarding the validity, high points, or general evaluation of individual MMPI profiles.

California Psychological Inventory (*CPI*).—Gough (181) has reported a cross-validation study of a new leadership index based on CPI scales. Gough, Chun &

Chung (182) found that the CPI Femininity scale functioned validly with a Korean sample, although not at the level obtained in earlier studies. Leventhal (269) has reported new norms and test-retest reliabilities for an Anxiety scale based on CPI items. Vingoe (419), using peer ratings, self ratings, and derived measures of self acceptance, found support for the validity of the Dominance, Sociability, and Self-Acceptance scales of the CPI, but not for the Responsibility scale. Conflicting evidence was obtained for the Psychological Mindedness scale.

Schludermann & Schludermann (362) report that the factor structure of the CPI based on a Canadian sample is highly similar to that obtained with samples from the United States.

Correlations have been reported between scores on CPI scales and scores on the Edwards Personality Inventory (2). CPI scales have also been found to be correlated with academic achievement (107), creativity (108, 325), serum cholesterol level (235), peer group effects on treadmill performance (249), and sex role identification (270).

Edwards Personal Preference Schedule (EPPS) and Personality Research Form (PRF).—The EPPS and PRF scales are attempts to measure various needs in the Murray system. The EPPS consists of 225 forced-choice items and is scored for 15 ipsative need scales. The PRF has two parallel short forms and two parallel long forms with items in a True-False format and provides scores on 15 and 20 need scales, respectively. Edwards, through the use of the forced-choice item format, and Jackson, through the use of balanced True-False scales and careful item development, have sought to minimize the influence of response styles on scale scores. Edwards, Abbott & Klockars (125) have identified the common trait dimensions of the EPPS and PRF and found, in general, that the EPPS and PRF scales with the same or similar trait names had their highest loadings on a common factor.

Evidence regarding the construct validity of various EPPS scales has been reported in a number of studies (340, 354, 431, 438). Scores on the EPPS scales have been found to be correlated with scales of the Strong Vocational Interest Blank (250), the Personal Orientation Inventory (268), the Allport-Vernon-Lindzey Study of Values (385), dogmatism (403), repression-sensitization (165), and sensation seeking (428). Goss (179) has investigated the need patterns of patient populations, and Waters (429) studied the stability of EPPS scale scores over a seven-week interval.

Correlates of EPPS scales have been investigated in studies of academic achievement (10, 23, 163, 279), vocational outcome of psychiatric patients (104), creativity (254), rotary pursuit performance (62), church attendance (289), persistence in psychotherapy (413), facilitating and debilitating anxiety (427), and heterosexual somatic preferences (436).

Groups studied with the EPPS have included seminary students (53), women athletes (98), Navy volunteers for Antarctic service (188), ROTC students (322), disturbed adolescents (328), obese university females (329), alcoholics (344), smokers (350), light drinkers (351), engaged couples (349), and paranoid schizophrenics (404).

The PRF items and scales have been used in a series of methodological studies (227, 228, 255). Pierce (336) used the PRF in an investigation of friendship choice and Hoffman (205) in a study of the personality traits of student nurses. Siess & Jackson (381), using a multimethod factor analysis of the PRF and Strong Vocational Interest Blank, found significant convergent validity between measures of interests and measures of personality traits.

Sixteen Personality Factor Questionnaire (16 PF).—In a study of the 16 PF, Cattell, Eber & Delhees (64) concluded that the number and nature of the 16 factors was confirmed in a sample of 606 men and women. Howarth & Browne (217, 218), however, failed to replicate the 16 PF factors and concluded that the 16 PF does not measure the factors it purports to measure at the primary level. The failure of the 16 PF items to load on the appropriate factors was also reported by Sells, Demaree & Will (372, 373).

Four studies have investigated the interrelationships between the 16 PF and the MMPI scales (63, 99, 222, 319). Crookes & Pearson (86) related scores on the 16 PF to scores on the Eysenck Personality Inventory scales. Stereotypic desirability profiles for the 16 PF were generated by Meredith (301), and Lebovits & Ostfeld (264) concluded that the 16 PF scores were significantly correlated with defensiveness.

Scores on the 16 PF have been found to be correlated with scores on various other personality scales including sensation-seeking (178), hypnotizability (353), and need for approval (363).

The 16 PF scales have been investigated in relation to academic achievement (11, 111), intelligence (87, 242), homosexuality (137), age differences (174), perceptual phenomenon (266), basal skin resistance (16), frequency of dream recall (79), and peak experiences (290).

Groups which have been studied with the 16 PF include reformatory inmates (81), alcoholics (170), child guidance clinic patients (240), and music therapists (376).

Eysenck Personality Inventory (EPI) and Maudsley Personality Inventory (MPI).—Both the Eysenck Personality Inventory and its precursor, the Maudsley Personality Inventory, provide scores on Extraversion (E) and Neuroticism (N). A Lie scale is also scored on the EPI. However, Williams (437) found the Lie scale score of little value in identifying dissimulators, and Salas & Richardson (358) found little equivalence between the Lie scores on Forms A and B of the EPI. Farley (140) found that E and N scores on the MPI and EPI were substantially correlated, and in the following discussion no differentiation will be made between the Eysenck and Maudsley measures of E and N.

E or N scores have been investigated with respect to impulsivity (141, 142), aggression (159), rigidity and dogmatism (110), occupational choice (216), affiliation and anxiety (375), manifest anxiety (379), sensation seeking (29), repression-sensitization (93), academic achievement (136), personal space (300), voice expression (253), and difference in responses to neutral and emotional words (49).

Experimenters have also attempted to relate E or N scores to physiological measures such as blood pressure (96), alpha rhythm (47), pupillary changes (157), EEG patterns (162), salivation (220, 343, 347), pain tolerance (95), visual sensitivity (380), auditory thresholds (390). visual after-images (435), and critical flicker frequency (15).

Within a learning paradigm, investigators have attempted to relate E or N scores to autonomic conditioning (310), eyelid conditioning (337), incidental learning (20), serial learning under distraction (215), paired-associate recall (219, 294), escape and avoidance learning (320), and pursuit rotor performance (374).

E or N scores have been reported for depressed patients (164, 239), manic-depressive patients (338), and as a function of age, sex, and social class (139).

Personal Orientation Inventory (POI).—The POI was constructed to provide measures of some of the personality traits relevant to self-actualization theory. Correlations of POI scales with various other scales have been reported including locus of control (424), repression-sensitization (153), the EPPS scales (268), and the Gordon Personal Inventory scales (37).

The validity of POI scales has been investigated in a number of studies (92, 156, 183, 288). Ilardi & May (224) concluded that their findings with respect to the reliability of the POI scales were inconclusive but encouraging. Silverstein & Fisher (383) have investigated the influence of item overlap in POI scales on the factor structure of the scales.

POI scales have been used in studies of sensitivity training groups (90), academic performance (267, 399), identity achievement (384), and personality characteristics of volunteers for psychological experiments (377).

Edwards Personality Inventory (EPI).—The EPI consists of four booklets with 300 items in each booklet in a True-False format. A total of 53 scales with non-overlapping items can be scored in the EPI, with 14 of these scales having parallel forms in another booklet.

Edwards (118) found that when items in one of the EPI booklets were stated in the first person form, scores on the scales were highly correlated with scores on the same scale when the items are stated in the third person form. Fiske (149) has replicated this finding, but reports that scales in the third person form had higher internal consistency coefficients than the scales in the first person form.

Oakland has reported normative data on the EPI for a sample of high school students (317) and also the relationship of the EPI scales to achievement of high school students (318). He found that a number of EPI scales were substantially correlated with over- and under-achievement of the students in his sample.

The trait dimensions measured by the EPI have been related to the dimensions measured by the CPI (2), EPPS and PRF (123), and the 16 PF, CPI, and EPPS (122).

Comrey Personality Scales (CPS).—Beginning with three factor dimensions' Comrey and his associates (73, 115, 232, 233) have expanded the number of dimensions to eight. The culmination of this research has been the publication of the CPS (74). The construct validity of the CPS scales has been investigated by comparing scores on the scales with information obtained from a biographical data questionnaire (75).

Omnibus Personality Inventory (OPI).—Elton & Terry (133) found that the factor structure of the OPI was stable over a four-year period. Correlations of the OPI scales with the A-B therapist scales have been reported by Dublin, Elton & Berzins (114). The OPI scales have also been investigated with respect to patterns of change in personality test scores (130), characteristics of low income males (131), sociosexual adjustment (202), creativity (433), and inferred personality characteristics of college students (132) based on Astin's (8) analysis.

Allport-Vernon-Lindzey Study of Values (AVL).—The construct validity of the AVL has been investigated by Arsenian (7) and Simon (385). Abbott (1) found that scores on the AVL were uncorrelated with measures of social desirability, acquiescence, and impression management. AVL scales have also been used in a study of esthetic sensitivity (59).

Differential Personality Inventory (DPI) and Spiegel Personality Inventory (SPI).—Two new multiscale inventories have been constructed which attempt to measure personality traits primarily relevant to psychopathology. The DPI was constructed using the same methodological procedures involved in constructing the PRF and is scored for 12 clinical and 3 validity scales (230). The DPI has been used in a study of transvestites (18) and with alcoholics (327).

The SPI was developed by Spiegel (392) and consists of 200 items which are scored on 35 scales. Normative data on the SPI scales have been reported for alcoholics, psychiatric inpatients, and normals (394). Correlations of the SPI scales with the MMPI scales have been reported (391), as have correlations of the SPI scales with the CPI and AVL scales and the dogmatism scale (395). The SPI scales have been used in a study of psychopathology (391), of tactual appeal (396), and of the "funniness" of cartoons (393).

Adjective check lists.—Research with adjective check lists has continued during the period under review. Sciortino (366–369) has investigated the factor structure of the Intellective Adjective List (IAL) and General Adaptability Adjective List (GAAL), and Lange (258) has investigated the factor structure of the Interpersonal Check List (ICL).

Parker & Veldman (324) factor analyzed the item correlations of the Gough Adjective Check List (ACL) and interpreted 7 factors. The first factor, accounting for the most variance, was regarded as a social desirability factor. In a subsequent study, Veldman & Parker (414) developed factor scales based on their item factor analysis and were able to replicate the item factor structure using the scale intercorrelations.

New scales developed for the ACL include a masculinity-femininity scale (323) and two creativity scales (109, 388).

Scores on various ACL scales have been found to be related to tolerance of ambiguity (82) and educational level (225). Von Singer & Pederson (421) have investigated some behavioral correlates of the ACL scales. Groups studied with the ACL have included bright college freshmen (285), creative adolescents (361), and teachers (432).

SCALES

In this section we discuss briefly the Marlowe-Crowne (MC) and Masculinity-Femininity (Mf) scales and, in addition, a number of miscellaneous scales and new scales. Theory testing research studies involving the Manifest Anxiety (MA), Repression-Sensitization (RS), Locus of Control (LC), and Extraversion-Introversion (E) scales will be discussed in a later section.

MC scale.—The MC scale was originally developed as a measure of the tendency to give socially desirable responses (88). However, the MC scale was found to have a relatively low correlation with Edwards' Social Desirability (SD) scale, and scores on the MC scale were subsequently interpreted by Crowne & Marlowe (89) as measuring "need for social approval." Some investigators have also interpreted scores on the MC scale as measuring defensiveness or impression management or role-playing tendencies.

Scores on the MC scale have been found to be correlated with scores on the Self-Analysis Scale (363), with yea-saying tendencies (186), achievement (286), and hostility (193), but not with scores on the Ambiguity Tolerance scale (282).

Within an experimental context, scores on the MC scale have been investigated with respect to attribution of blame (102), verbal conditioning of self-referent statements (105), the presence and absence of an experimenter (199), defensiveness (208, 305), cheating (260), verbal learning (306), experimenter bias effect (389), and nonzero sum games (405).

Mf scales.—Several studies (25, 234, 280) have failed to demonstrate the convergent validity of various Mf scales. Mf items in a cross-validation study failed to differentiate between males and females (34), and in a factor analysis of the items from various Mf scales Lunneborg & Lunneborg (280) found that the items failed to load on a common factor. It has also been reported that many items included in Mf scales, which would commonly be judged as differentiating between males and females, actually fail to do so (278). Manosevitz (283), on the other hand, found that 13 of the items in the Mf scale of the MMPI differentiated between male homosexuals and a control group.

Miscellaneous scales and inventories.—Evidence regarding the construct validity of various scales, tests, and inventories has been reported, including: the Zung Depression scale (304), Gordon Survey of Interpersonal Values (176, 311), Michill Adjective Rating Scale (345), Barrett-Lennard Relationship Inventory

(422), Shallow Affect Scale (42), self-expressive styles (187), Opinion, Attitudes, and Interest Survey (158), scales of dominance (101), Accurate Empathy Scale (55, 67, 417), Death Anxiety Scale (195, 406), Guilt Embarassment Scale (112), Mosher Sex Guilt scale (160, 161, 333), Buss-Durkee Hostility Scale (248), self-peer rank method of measuring need achievement (210, 211), Sensation-Seeking Scale (246, 314, 442, 443), the Myers-Briggs Type Indicator (247), self-concept dimensions (12, 418), Self-Esteem Inventory (33), the Self-Disclosure Inventory (223, 420), and the Guilford-Zimmerman Temperament Survey (166, 356).

The construct validity of a number of different anxiety scales has been investigated, including the Alpert-Haber Achievement Anxiety Test (61, 100, 236, 274, 293), Stimulus-Response Inventory of Anxiousness and Hostility (134, 135, 378), and test anxiety scales (14, 106, 221, 321, 348, 352, 360).

New scales.—New scales have been reported for measuring psychosexual development (68), coldness-warmness (145), use of defense mechanisms (167), impulse control (263), ambiguity tolerance (282), self perception (284), affiliation and sensitivity to rejection (298), id, ego, and superego tendencies (382), motivational constructs (434), self-actualization (30), and social desirability tendencies in children (152).

Other constructs for which scales have been developed include altruism (262, 423), empathy (66, 94, 207), fear of death and dying (72), guilt tendenices (313), hostility (80, 335), under- and over-confidence (83), Protestant ethic (308), need achievement (281, 297), novelty seeking (332), social-personal orientation (58), and social self-esteem (56, 339, 441).

SOCIAL DESIRABILITY SCALE VALUES (SDSVs)

The SDSVs of personality items are obtained by having judges rate the items on a 9-point scale ranging from extremely undesirable through neutral to extremely desirable, in accordance with instructions described by Edwards (116, 120). The SDSV of an item is simply the average rating assigned to the items. The SDSVs of large and representative sets of personality items have been found to be highly reliable and highly correlated over diverse groups of judges (120).

Gray & Gynther (185), in a study of the sex items from the MMPI, found no significant main effects with respect to the SDSVs of these items for sex of the judges, sex of the experimenter, and need for approval. In a similar study with the religious items of the MMPI (189), the mean SDSVs of these items were found to be related to religious affiliation.

Walsh (425) has investigated the influence of anchoring stimuli on items with neutral SDSVs that differ in their dispersions. The influence of instructional sets on SDSVs of items has been investigated (60) as have position and sequence effects (206).

Several studies (22, 231, 426) have investigated the interrelationships between SDSVs of personality items, probability of endorsement of the items, and judged likelihood of occurrence of the traits represented by the items. All three of these item properties have been found to be highly intercorrelated.

Anderson (4) has reported "likeableness" ratings for 555 personality characteristics. Kirby & Gardner (245), on the basis of a sample of Anderson's traits, report that "likeableness" ratings correlated .98 with the SDSVs of the same traits.

EVALUATIVE AND DESCRIPTIVE CONSISTENCY

There is clear evidence to show that if judges are asked to describe someone they know and like and of the same age and sex as themselves, they are much more likely to attribute socially desirable traits to the individuals being judged than socially undesirable traits. In fact, the relationship between the probabilities of attributing traits to persons liked and the SDSVs of the traits is linear. In one study (117) the correlation between these two variables was .95 for female judges and .93 for male judges. In describing someone disliked the correlations were negative, but of considerably smaller magnitude than those obtained when judges described someone they liked.

In experimental studies of trait inferences, instead of being asked to describe someone they know, judges are typically presented with one or more trait terms which they are told are descriptive of a subject and are then asked to make judgments as to whether other trait terms are also descriptive of the same subject. The evidence from these studies indicates that judges tend to infer socially desirable or favorable traits from other favorable traits and socially undesirable or unfavorable traits from other unfavorable traits. This tendency has been described as "evaluative consistency."

Peabody (330) has pointed out that it is possible for two trait terms to be similar with respect to both an evaluative and a descriptive dimension and that in trait inference studies the two are often confounded. For example, if a judge infers that a subject is "considerate" because he has been told that the subject is "kind," does he do so because both traits are socially desirable (evaluative consistency) or because both traits share a common descriptive quality (descriptive consistency)? Using a set of trait terms that he believed to avoid the usual confounding between evaluative and descriptive similarity, Peabody reported evidence which he regarded as conclusively demonstrating the dominance of descriptive consistency over evaluative consistency. Peabody's conclusions have not gone unchallenged.

Rosenberg & Olshan (355) have pointed out that the absence of an evaluative dimension in Peabody's factor analysis seems to have resulted from a scoring artifact which would have discarded relevant information about this dimension. Using 80 of Peabody's trait terms and a multidimensional scaling program, they found a general evaluative dimension. In another study, Felipe (144) reported evidence to support both evaluative and descriptive consistency. Peabody (331), in a reappraisal of his own results and those of Felipe and Rosenberg & Olshan, concludes: "(*a*) In the covariation of many traits, evaluative and descriptive relations are of comparable importance; (*b*) in separate trait judgments, descriptive effects are the more important when descriptive relations are strong; (*c*) in the combining of several traits, it is the descriptive effects that are enhanced" (331, p. 639).

The studies described above were concerned with trait inferences. Edwards (119) used Peabody's trait terms to obtain self descriptions. A score of 1 was assigned to a True response and a score of 0 to a False response to each trait term. Subjects were under instructions to describe themselves, and their responses to the trait terms were intercorrelated and factor analyzed by the method of principal components. The first factor loadings of the trait terms were found to be linearly related to the social desirability or evaluative values of the terms. Trait terms with positive evaluative signs had positive loadings on the first principal component, and those with negative evaluative signs had negative loadings. This was true even for those paired trait terms judged by Peabody to be descriptively similar, such as "cautious" and "timid." Apparently this first factor represents an evaluative or social desirability dimension which cannot be accounted for in terms of descriptive consistency.

RESPONSE STYLES

Social desirability.—A Social Desirability (SD) scale has been defined as one in which all of the items are keyed for socially desirable responses (116). A socially desirable response to an item, in turn, has been defined as a True response to an item with an SDSV$>$5.0 or as a False response to an item with an SDSV$<$5.0. Although a fairly large number of different SD scales have been investigated and found to have high loadings on a common factor (120), the one that has been most frequently used in research consists of 39 items which are scored in the MMPI. The MMPI SD scale has been found to be an excellent marker for the first principal component obtained when MMPI scales are intercorrelated and factor analyzed. First factor loadings of MMPI scales have also been found to be directly related to the proportion of items in the scales keyed for socially desirable responses.

Using cluster analysis and a sample of male adults selected to be heterogeneous in emotional disturbance, Tryon (409), Stein (397), and Chu (69) developed seven new scales from the MMPI item pool. The seven scales, described as measuring Introversion, Body Symptoms, Suspicion and Mistrust, Depression, Resentment, Autism, and Tension, were believed to represent the major content dimensions of the MMPI item pool. A principal component factor analysis of the TSC scales has been reported by Edwards, Klockars & Abbott (128). The analysis included three marker variables for the first three MMPI principal components: the SD, R, and Lie scales. All seven of the TSC scales were found to have positive loadings greater than .61 on the first principal component on which the SD scale had a loading of $-.91$. All but four of the items in the TSC scales are keyed for socially undesirable responses, whereas all of the items in the SD scale are keyed for socially desirable responses, and the results were interpreted as being consistent with previous findings regarding MMPI scales which contain an extreme imbalance in their social desirability keying.

A replication of the above study was carried out using the correlations between the TSC scales obtained from the Tryon sample (124). The results obtained with the Tryon sample were essentially the same as those obtained with the college sample, except that, in general, the loadings of the TSC scales from

Tryon's sample were higher on the first principal component than for the college sample, as was also the loading of the SD scale (−.99). The investigators concluded that there was considerable redundancy in the seven TSC scales in that each of them had its highest loading on the first principal component. Stein (398) has objected to this conclusion, pointing out that the TSC scales are keyed for maladjustment and therefore to consider the scales as redundant measures of social undesirability is a reductionism that is conceptually narrow and unfruitful. The fact remains that there is considerable redundancy in the TSC scales regardless of whether they are interpreted as measuring "maladjustment" or as measuring the "tendency to give socially undesirable responses in self-description."

Millimet (307) pooled items in 10 MMPI scales, presumably measuring anxiety and defensiveness, to develop a new MMPI scale which he called Manifest Anxiety-Defensiveness (MAD). The MAD scale was subsequently found to correlate −.86 (males) and −.91 (females) with the SD scale.

Kimble & Posnick (243) constructed a scale which matched the items in the Manifest Anxiety (MA) scale in terms of grammatical structure and social desirability but in which the content was believed to be irrelevant to the construct of anxiety. They found that scores on their scale correlated .73 with the MA scale. Edwards, Cone & Abbott (126), in turn, constructed a scale in which the items did not have the same grammatical structure and in which no attempt was made to include items with content relevant to anxiety. The SDSVs of the items in this scale were fairly comparable to the SDSVs of the items in the MA scale, and the scale was found to correlate .71 with the MA scale and .69 with the Kimble-Posnick scale. The investigators account for the correlation between their scale and the Kimble-Posnick scale as resulting from the fact that 80 percent of the K-P items were keyed for socially undesirable responses and 84 percent of their items were keyed for socially undesirable responses. All of the MA items were keyed for socially undesirable responses.

Golin, Herron, Lakota & Reineck (171) found that the MA and RS scales correlated .87, and they concluded that scores on the two scales have the same psychological meaning. Sullivan & Roberts (402), however, showed that the correlation between MA and RS cannot be attributed to the fact that they have a substantial number of MMPI items in common. When the common items were eliminated from the RS scale, the scale was still found to have a correlation of .86 with the MA scale. Liberty, Lunneborg & Atkinson (272) found some years ago that both the MA and RS scales had high loadings, −.87 and −.94, respectively, on the first principal MMPI factor on which the SD scale had a loading of .87.

Although the MA and RS scales have items in common with the SD scale, the high negative correlations of these two scales with the SD scale cannot be attributed to item overlap. Abbott (3), using items from the Edwards Personality Inventory, constructed a Balanced Social Desirability (BSD) scale in which 20 items were keyed for True and 20 for False responses. The BSD scale correlated

.75 with the MMPI SD scale, −.77 with the RS scale, and −.77 with the MA scale.

The relatively low correlations found between scores on the Marlowe-Crowne (MC) scale and Rotter's Locus of Control (LC) scale resulted in Lefcourt's (265) conclusion that scores on the LC scale are relatively free from social desirability tendencies. As Cone (76) has correctly pointed out, the MC scale is modeled after the Lie scale of the MMPI and does not measure the same construct as the SD scale. For a sample of male soldiers referred to a mental health outpatient clinic, Cone found that the LC and SD scales correlated −.70. For two different samples of male soldiers confined in a stockade, the correlations between the LC and SD scale were −.47 and −.46. For a sample of economically disadvantaged young people the correlation between the LC and SD scales was −.29, and for a sample of alcoholics the correlation was −.32.

Most of the research with the SD and LC scales has been done with college students. As yet, no one has provided an estimate of the correlation between these two scales for a sample of this kind.

Acquiescence.—Bentler, Jackson & Messick (17) have differentiated between "agreement acquiescence" and "acceptance acquiescence." In the personality domain, the first type has traditionally been defined as individual differences in the tendency to respond True or to agree with personality statements. The second type is defined by Bentler, Jackson & Messick as individual differences in the tendency to accept characteristics as self-descriptive. Block (26), in a reply, fails to acquiesce with the Bentler, Jackson & Messick position. Block is critical of both the methodology and results of the studies cited by Bentler, Jackson & Messick and believes that they have failed to provide any positive and systematic evidence attesting to the importance of agreement acquiesence or acceptance acquiescence in structured personality inventories.

One of Block's criticisms is that the construct validity of scales designed to measure acquiescent tendencies has not been demonstrated. If a scale is to measure agreement acquiescence, then all of the items in the scale should be keyed for either True responses or for False responses so that high scores, in the case of True keyed scales, or low scores, in the case of False keyed scales, would presumably measure the construct. On the other hand, if all of the items in the scale have SDSVs$>$5.0 or SDSVs$<$5.0, then the acquiescent keying of the items would be completely confounded with the social desirability or undesirability keying and scores on the scale could be expected to be highly correlated with scores on the SD scale.

In principal component analyses of MMPI scales, the R scale usually has a relatively low loading on the first principal component and a relatively high loading on the second principal component. All of the items in the R scale are keyed for False responses; the SDSVs of the 40 items spread across the complete social desirability continuum with a median value of approximately 5.8; and the scale has a relatively low correlation with the SD scale. Furthermore, the second component factor loadings of MMPI scales have been found to be directly related to the proportion of items in the scales keyed for True responses (127). If the second factor of the MMPI is interpreted as agreement acquiescence, then the R scale obviously is a relatively good measure of this construct.

Further evidence regarding the construct validity of the R scale as a measure of agreement acquiescence has been reported by Edwards & Abbott (121). MMPI items were sorted according to their SDSVs, and 26 scales were constructed simply on the basis of the SDSVs and without regard to the content of the items. The 20 items with the lowest SDSVs were selected to form Scale 1, the next 20 to form Scale 2, and so on, with Scale 26 consisting of the 10 items with the highest SDSVs. All of the items in each of the 26 scales were keyed for True responses, and scores on the 26 scales were then correlated with scores on the R scale. All 26 of the correlation coefficients were negative. The items in the 26 scales exhaust the MMPI item pool, and the results obtained would seem to provide additional evidence that the R scale has construct validity as a measure of agreement acquiescence with respect to MMPI items.

In another study, Bock, Dicken & Van Pelt (28), using an analysis of variance model, conclude that some variance attributable to acquiescent tendencies is undoubtedly present in MMPI scores but that it is small relative to content variance. Whether the variance they attribute to content is actually content variance or social desirability variance is not considered.

Bernhardson (21) obtained SDSVs for 56 MMPI items and their reversals and also responses of individuals to the original and reversed items. He suggests that double agreement or double disagreement with the original and reversed personality items may be the result of social desirability rather than a tendency to agree or disagree.

In another item reversal study, McBride & Moran (287) report that there is a positive correlation between need for approval and double agreement to original and reversed attitude items and that high need approval subjects tend to view both original and reversed items as more ambiguous than low need approval subjects.

Extreme response set.—Hamilton (192) has reviewed much of the literature regarding the relationship between personality variables and extreme response set. Iwawaki & Zax (226) found that neurotics made more extreme ratings than nonneurotics and that stable introverts made fewer extreme ratings than neurotic extraverts. Norman (315) obtained results which suggest that high anxiety (high scores on the A and low on the R scale of the MMPI) is related to the use of extreme response tendencies and that repression (low A and high R) is related to the use of neutral categories. Adjusted subjects (low A and low R) tended to make more use of intermediate categories. Worthy (440), on the other hand, has argued that the midpoint or neutral category should also be regarded as an extreme response set. Merrens (302) presents results to indicate that extreme response set is a general and not a specific trait. Parsonson (326) has suggested that extreme response set tendencies may be related to sex-role expectancies.

ROLE PLAYING

A considerable number of studies have been concerned with the influence of fake good or fake bad instructions on various personality inventories. As a result of a study with the Self-Perception Inventory, Braun & Tinley (46) conclude that the inventory is "grossly transparent." Fake good instructions on the Minnesota Counseling Inventory were found to result in more favorable scores on six out of seven scales (40).

Fisher & Silverstein (147) report that fake bad instructions with respect to the Personal Orientation Inventory (POI) resulted in lower scores. Interestingly enough, fake good instructions on the same inventory were also found to result in lower scores (44, 154). Under "ideal" self instructions inconsistent results were obtained; scores on some scales of the POI were higher and scores on other scales were lower (39). Surveying a number of studies done with the POI, Braun & LaFaro (44) conclude that unless subjects have special information about the POI and self-actualization, the inventory is resistant to faking.

Braun & Constantini (41) found relatively small differences in mean scores on the Personality Research Form (PRF) AA under fake good and standard instructions, whereas Braun & Asta (38) report substantially larger differences on the shorter PRF A. On the other hand, Hoffman (204), using a relatively small sample of patients with a diagnosis of personality disorders, found that fake good instructions had relatively little influence on mean scores on the PRF A, but that fake bad instructions resulted in fairly large differences.

Both fake good and fake bad instructions were found to influence scores on the 16 Personality Factor Questionnaire (45, 301). No significant differences were found between fake good and standard instructions on the Zung Self-Rating Depression Scale by Mikesell & Calhoun (303). They report, however, that fake bad instructions on the same scale significantly increased scores. Braun (36) reports that, compared with other inventories, the Edwards Personality Inventory, Booklet IV, is surprisingly resistant to faking.

Under instructions to create the "best" impression on Mosher's Forced-Choice Guilt Inventory, it was found that subjects obtained higher guilt scores than under standard instructions, whereas under instructions to create a "bad" impression, guilt scores were lower than under standard instructions (113). Braun & LaFaro (43) report that both contact and distortion scores on the Contact Personality Factor Test are significantly increased under faking instructions. A study with the Gordon Personality Inventory and Profile indicates that if the same subjects are tested under standard and fake instructions, the order of administration is of importance (365).

Gorman (177) found that the items in the Neuroticism (N) scale of the Eysenck Personality Inventory had socially undesirable scale values, whereas the Extraversion (E) items were rated as highly desirable. He reports that most of his subjects could successfully fake good or fake bad on demand and that the different score patterns obtained from fake good and fake bad instructions were predictable from the desirability ratings of the items. Consistent with Gorman's results, Skinner, Howarth & Browne (386) report that asking subjects to simulate a "nice" personality resulted in lower scores on N and higher scores on E. On the basis of results obtained under fake bad and standard instructions, Salas (357) concluded that the Eysenck Personality Inventory shows little promise of discriminating malingerers from genuine neurotics. Power (341) and Power & O'Donovan (342) have investigated dissimulation on the Maudsley Personality Inventory.

All of the above studies simply indicate the degree to which mean scores on personality inventories and scales are altered or changed when subjects are specifically asked to role play. When individuals are asked to fake good or fake bad on a given scale or inventory, there are individual differences in the degree to which they can successfully do what they have been asked to do. In an important study, Stricker (400) has presented evidence to indicate that role-playing success on a given scale does not generalize to performance on other personality scales.

Role playing or impression management studies in which subjects are asked to fake their responses leave unanswered the question of the degree to which the tendency to fake may be operating when inventories and scales are administered under standard instructions (120). If role playing does occur under standard instructions, then presumably scores on the scale should be correlated with those underlying variables that make for successful role playing. Stricker (400) refers to these variables as measures of "test-wiseness." In his study, however, he found relatively low correlations between a number of different measures of test-wiseness and scores on personality scales when administered under standard instructions. The question of which, if any, and to what degree subjects fake responses when they respond to the items in a scale or inventory under standard instructions is one that still remains to be answered.

CONVERGENT AND DISCRIMINANT VALIDITY

In what has by now become a classic article on psychological measurement, Campbell & Fiske (54) proposed that any scale designed to measure a given trait should be shown to have both convergent and discriminant validity. Simply stated this means that a scale designed to measure a given trait should not be too highly correlated with scales measuring different traits, whereas it should be highly correlated with other measures of the same trait. To determine the convergent and discriminant validity of various scales, they proposed the use of a multimethod-multitrait matrix consisting of the intercorrelations of different traits measured by different methods, and they provided informal criteria for evaluating the matrix.

Norman (316) has presented the results of a series of studies on the convergent and discriminant validity of peer and self-ratings and personality questionnaires. Other studies have reported on the convergent and discriminant validity of various measures of liberalism-conservatism (200), needs (35, 296, 340), ego-identity (13), sense of humor (252), creative ability (172), self-esteem, dominance, and dogmatism (194), cognitive style (312), children's traits as obtained from retrospective reports (52), and of the Clyde Mood Scale (148).

An analysis of variance model has been used to evaluate method, trait, and error variance associated with measures of leadership (31) and with performance ratings (241). Another model, a maximum likelihood factor solution, has been proposed by Jöreskog (238) for evaluating method, trait, and error variance. Jöreskog has applied his model to a multitrait-multimethod matrix originally cited by Campbell & Fiske. Another application of a maximum likelihood factor solution has been provided by Boruch & Wolins (32).

Jackson (227) has described what he refers to as a multimethod factor analysis for evaluating multitrait-multimethod matrices. In essence, he substitutes an identity matrix (unity in the diagonals and zeros elsewhere) for the monomethod submatrices in the multitrait-multimethod matrix. The resulting multitrait-multimethod matrix is then factor analyzed by the method of principal components. Jackson has used multimethod factor analysis to evaluate a matrix involving the intercorrelations between two forms of the PRF. Kusyszyn & Jackson (255) have provided a comparison of the results obtained with a multimethod factor analysis and with a standard principal component analysis. Lorr & Hamlin (277) have applied multimethod factor analysis to behavioral and objective measures of psychopathology.

Conger (78) has criticized Jackson's multimethod factor analysis on a number of grounds and has argued that it is biased in the direction of confirming convergence for similar traits and divergence for dissimilar traits. Jackson (229) has replied that Conger's criticisms are essentially irrelevant.

The arbitrary substitution of identity matrices, as recommended by Jackson, for the monomethod submatrices in the supermatrix is not equivalent to a Gram-Schmidt or some other mathematical orthogonalization of these submatrices. A Gram-Schmidt orthogonalization (213) or any other mathematical orthogonalization will result in some adjustments to the intercorrelations within the heteromethod submatrices, whereas these entries remain unchanged if Jackson's procedures are followed.

It can be proved that if we have two methods with k traits measured by each method and if the monomethod submatrices have been subjected to a Gram-Schmidt orthogonalization, then a principal component analysis of the resulting supermatrix must necessarily result in k principal component factors with eigenvalues greater than 1 and k principal component factors with eigenvalues less than 1.[3] Thus we will necessarily obtain as many factors (k) as we have different scales or traits, each with an eigenvalue greater than 1. If the correlations between the two methods of measuring each of the same traits are relatively high, and the intercorrelations between the different traits are moderately low, then in the square correlation supermatrix of order $2k$, each column will contain two high values, "1" and the high correlation between the paired traits, $k-1$ values which are equal to 0, and $k-1$ moderately low values representing the correlations of the trait with different traits measured by a different method. Furthermore, the two columns corresponding to each pair of traits will each have two high values in each of two rows, and these rows will be different for each pair of traits. Under these conditions, it is not unreasonable to expect that each of the *k* factors with eigenvalues greater than 1 will have, after a Varimax rotation, two relatively high loadings.

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[3] Horst, P. Personal communication.

To test the above prediction, we did the following unpublished study with the Edwards Personality Inventory (EPI) which provides measures of 53 normal personality traits. Booklets IA and IB of the EPI provide comparable measures on 14 of the 53 traits. For the remaining 39 traits we subdivided the items in each of the 39 scales into two halves and obtained scores on each half scale as though they represented comparable forms. We then obtained a matrix of order 106×106 of the intercorrelations of the 106 scales. We did a Gram-Schmidt orthogonalization of the intercorrelations of the 53 scales within each form and obtained a supermatrix with a 53×53 identity monomethod submatrix for each form and with the intercorrelations between forms adjusted accordingly. A principal component factor analysis of this 106×106 matrix resulted, as it must, in 53 factors, each with an eigenvalue greater than 1. A Varimax rotation of these 53 factors resulted in 53 factors with two quite high loadings (the lowest being .70) on each of the factors. All other loadings on each factor were quite low, the highest being .22. This rotated factor loading matrix is an almost ideal case of a simple structure matrix.

We should note, however, that a principal component analysis of the intercorrelations of the 53 EPI scales does not result in 53 factors with eigenvalues greater than 1, but only in 14 such factors. We suggest that, at least in the case of two methods (or forms) with the same *k* traits measured by each method (or form), *and under the conditions described,* multimethod factor analysis will tend to confirm convergence for similar traits and divergence for dissimilar traits.

An important question, however, is the interpretation of the factor loadings obtained with a multimethod analysis. It would appear from Jackson's discussion that he regards these loadings as the factor loadings of the *scales*. In discussing the results of a multimethod factor analysis of comparable forms of the PRF, for example, he states "no irrelevant scale substantially loads a factor defined by parallel scales, and the loadings for relevant pairs of scales are uniformly high and very similar" (227, p. 42). And again: "The lowest loading for a parallel form measure on an appropriate factor is .82, while the highest absolute irrelevant scale loading on any factor is .26" (p. 42). If the factor loadings obtained with a multimethod factor analysis of the two forms of the PRF scales were in fact the loadings of the *scales* on the factors, then it should be possible to show that the correlations of the PRF scales with factor scores on the multimethod factors are indeed equal to the factor loadings. Neither a proof nor empirical evidence regarding this point is presented by Jackson.

IPSATIVE AND NORMATIVE SCALES

A set of two or more scales has been defined as ipsative if the sum of the scores on the set of scales is equal to a constant for each individual. For any set of *k* ipsative scales, scores on any given scale can be perfectly predicted from the scores on the remaining $k-1$ scales, and the rank of the correlation matrix of the ipsative scales cannot be greater than $k-1$. Well-known examples of sets of ipsative scales are the 15 scales of the EPPS and the 6 scales in the AVL.

In a review of ipsative, normative, and forced-choice measures, Hicks (201) takes a strong stand in favor of normative measures. He states: "The difficulties associated with purely ipsative measurement techniques derive directly from the defining characteristics of the technique: the sum of the scores obtained over the attributes for each individual must be a constant. This basic characteristic introduces into the ipsative score matrix many peculiar properties that are absent from normative and forced-choice normative matrices" (201, p. 181). There is, of course, nothing "peculiar" about an ipsative score matrix other than that the sum of scores for each individual is a constant and that this, in turn, results in certain mathematically predictable properties with respect to the covariance and correlation matrices of a set of ipsative measures (70, 71, 346).

After reviewing the limited work that has been done comparing the empirical "validity" of ipsative and normative measures, Hicks states that "one finds no clear evidence that such tests (ipsative) have ever been demonstrated to be superior to similar normative keys, although such superiority is sometimes reported" (201, p. 178). And again, "In any case, one does not find clearly superior validities associated with the purely ipsative technique" (p. 178). Scott (370) arrived at this same conclusion in an earlier review of forced-choice and single-stimulus scales. Granted that there is no conclusive evidence that ipsative scales have superior validities to normative scales, it must also be acknowledged that there is no conclusive evidence that, in practice, normative scales have superior validities to ipsative scales. Any choice between these two methods of measurement must, therefore, be based on grounds other than the validities of the two methods of measurement.

In a factor analysis that included both normative and ipsative measures, Atkinson & Lunneborg (9) obtained interpretable factors loaded by both ipsative and normative measures and factors loaded only by ipsative measures. They state that "finding interpretable factors loaded by both normative and ipsative scales may indirectly support the notion that the factor structure obtained from ipsative measures is not dissimilar from a normative structure" (p. 34).

Edwards, Abbott & Klockars (125) factor analyzed the EPPS scales, which are ipsative, and the PRF AA scales, which are normative, along with three other normative scales. They also found interpretable factors on which both ipsative and normative scales had high loadings. Of major interest in this case is the fact that there are a number of PRF normative scales with the same trait names as the EPPS ipsative scales. These paired ipsative-normative scales, in general, had high loadings with the same sign and of comparable magnitude on a common factor. For example, the two "order" scales loaded .79 and .79 on a common factor, the two "autonomy" scales loaded −.72 and −.60 on a common factor, the two "dominance" scales loaded .86 and .83 on a common factor, the two "endurance" scales loaded .83 and .70 on a common factor, and so on. These results obviously indicate that it is possible to construct both ipsative and normative measures of a common trait such that the paired ipsative and normative measures have comparable loadings on a common factor.

THEORY TESTING RESEARCH

There are a number of personality scales that have been developed within the framework of a general theory as to the nature of the construct which scores on the scale were designed to measure. Perhaps the most familiar example is the Taylor Manifest Anxiety (MA) scale. Eysenck's Extraversion-Introversion (E), Byrnes' Repression-Sensitization (RS), and Rotter's Locus of Control (LC) scales are other examples.

Scales of the kind described above readily lend themselves to "theory testing research" in which a relevant hypothesis, presumably based on some aspect of the theory underlying the scale, can be tested.[4] The theory is often vague, but this is not necessarily a handicap. Theoretically inclined investigators are often able, with the aid of a vague theory, to deduce hypotheses that they believe to be relevant to the theory, whereas if the theory were more precise they might not be able to do so. In some cases the relevance of the hypothesis to the theory may be apparent only to the investigator who formulated the hypothesis.

One of the simplest paradigms used in theory testing research is to obtain the correlation coefficient between scores on a scale and measures on some other variable that the theory dictates should be related to the scale scores. Alternatively, high and low scoring groups on the scale are selected and then the difference between the means of the two groups on the second variable is tested for significance.

In other cases, the high and low groups are administered the same treatment and then tested on a second variable. The theory in this instance predicts that the high and low groups will react differentially to the same treatment, and consequently the means of the two groups on the second variable will differ. But it is obvious that in the absence of control groups who do not receive the treatment, no conclusions can be drawn about the influence of the treatment itself. The minimum degree of sophistication in design would require that half of the low group be randomly assigned to a control and the other half to the treatment, and similarly with respect to the high group. In essence this design is a 2^2 factorial experiment in which the levels of one factor correspond to a personality variable and the levels of the other factor correspond to the presence or absence of a treatment. In these designs it is the interaction effect that is of primary interest.

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[4] The distinction between theory testing research and construct validity (85) research is, we believe, subtle but important. The Psychopathic Deviate (Pd) scale of the MMPI was developed empirically and in the absence of any theory regarding the nature of the trait. Subsequent research with the Pd scale has had to do primarily with the meaning of high and low scores on the scale or, in other words, with the construct validity of the scale. Eysenck's E scale, on the other hand, was developed within the framework of a general theory regarding extraversion-introversion. When the E scale is used in research, it is usually the case that some hypothesis deduced from Eysenck's theory is being tested. It is not the meaning of scores on the scale that is in question but rather the theory regarding the trait.

In our review of the literature we found 106 studies that we believed could be classified as examples of theory testing research. These studies are listed in a supplementary bibliography on deposit with the National Auxiliary Publications Service (see footnote, p. 241). Of these 106 studies 19 involved the E scale, 39 involved the LC scale, 14 involved the MA scale, and 34 involved the RS scale. We examined each of these studies to determine whether the theory was confirmed or supported or whether it was not. In some cases the results were doubtful in that the investigators claimed only partial support for the theory investigated. Table 1 shows the number of studies in which the outcome supported or confirmed, partially supported or confirmed, or failed to support or confirm the theory.

One of the major flaws in many behavioral science experiments is the failure of the investigator to give consideration to the power of a test of significance in relation to the magnitude of a theoretical effect, the variability of the measurements, and the number of subjects needed for reasonable protection against Type II errors. As a result, the outcome of a study may fail to confirm a hypothesis that would have been confirmed had the number of subjects been larger. Some unknown percentage of those studies listed in the Not Confirmed or ? columns of Table 1 might be moved to the Confirmed column had the number of subjects in the study been larger. Working against this, of course, is the well-known fact that single studies in which a hypothesis is confirmed need to be replicated and that frequently in the replication the outcome fails to reconfirm the hypothesis. Thus some unknown percentage of the studies listed in the Confirmed column of Table 1 would undoubtedly be moved to the Not Confirmed column upon replication of the experiment. In the face of these unknowns, we conclude that perhaps about 50 percent of the published studies concerned with theory testing research involving the E, LC, MA, and RS scales are successful in confirming the hypotheses they set out to test.

Now if a hypothesis is deduced from a theory, it should presumably have a better than 50 percent chance of being confirmed if tested, provided of course

TABLE 1. OUTCOMES OF 106 THEORY TESTING RESEARCH STUDIES

Scale	Hypotheses			Number of Studies
	Confirmed	?	Not Confirmed	
E	9	2	8	19
LC	19	6	14	39
MA	4	4	6	14
RS	10	6	18	34
Total all scales	42	18	46	106

that the theory is correct and that the hypothesis is, in fact, relevant to the theory. We suggest that the success rate of the published studies reviewed is such that the theories underlying these personality dimensions are only partially correct or else the hypotheses tested were in many cases irrelevant to the theory.

In theory testing research, even when the outcome of a study supports or confirms the theory, this result alone cannot be regarded as supporting the particular theory which supposedly underlies the scale. To paraphrase Fiske & Pearson (151, p. 57): When the RS scale is highly correlated with the MA scale, and both scales are highly correlated with the SD scale, conceptual distinctions no longer exist in any meaningful sense. Theory testing research when using a scale on which scores can be equated with three different interpretations seems impossible.

When an investigator engages in theory testing research he is obviously placing a high degree of confidence in the theory and also in the relevance of his hypothesis to the theory. There is an alternative to theory testing research, as it is customarily practiced, that we believe may be more promising in the long run. Instead of classifying subjects into high and low groups on a single scale and then observing the performance of these subjects on another variable, it would be possible to classify the subjects into high and low groups on the basis of their performance. In this instance, one could investigate not only the single theoretical scale, but also a number of other potentially relevant scales. An example of this kind of research is the study by Wiggins, Wiggins & Conger (436) in which male subjects were classified into a number of different groups on the basis of their preferences regarding female body types. It was then found that these preferences were related in a meaningful way to a number of different personality traits.

The design described above can easily be extended to the case where a treatment is involved. Subjects could be randomly divided into a control group that does not receive the treatment and an experimental group that does. The performance of both groups of subjects would then be observed on some variable of interest. These performance scores could then be used to assign subjects to high and low groups. One could then not only investigate the differences in the means of these various groups on the theoretical scale of interest, but also on other personality scales which may be relevant to the performance of the subjects. Granted that if a large number of personality traits are involved, some may, by chance, be expected to relate to performance. The remedy to this problem, of course, is replication of the research.

In her analysis of 226 substantive articles published in the 1968 volumes of the *Journal of Personality* and the *Journal of Personality and Social Psychology*, Carlson (57) concluded that "not a single published study attempted even minimal inquiry into the organization of personality variables within the individual" (p. 209). Obviously, as long as research workers continue to confine their investigations to single traits, as is currently the case, it will be impossible for them to give any consideration to the possible influence and interactions of other traits with the particular trait they have chosen to investigate.

LITERATURE CITED

1. Abbott, R. D. 1970. Stylistic response variance and trait inference from the Study of Values. *Psychol. Rep.* 27:911–14
2. Abbott, R. D. 1971. A factor analysis of the California Psychological Inventory and Edwards Personality Inventory. *Educ. Psychol. Meas.* 31:549–53
3. Abbott, R. D. 1972. On the confounding of the Repression-Sensitization and Manifest Anxiety Scales. *Psychol. Rep.* 30:392–94
4. Anderson, N. H. 1968. Likableness ratings of 555 personality-trait words. *J. Pers. Soc. Psychol.* 9: 272–79
5. Armentrout, J. A. 1970. Correspondence of the MMPI and Mini-Mult in a college population. *J. Clin. Psychol.* 26:493–95
6. Armentrout, J. A., Rouzer, D. L. 1970. Utility of the Mini-Mult with delinquents. *J. Consult. Clin. Psychol.* 34:450
7. Arsenian, S. 1970. Change in evaluative attitudes during twenty-five years. *J. Appl. Psychol.* 54:302–4
8. Astin, A. 1965. *Who Goes Where to College?* Chicago: Sci. Res. Assoc. 125 pp.
9. Atkinson, G., Lunneborg, C. E. 1968. Comparison of oblique and orthogonal simple structure solutions for personality and interest factors. *Multivar. Behav. Res.* 3: 21–35
10. Auvenshine, C. D., Smith, D. F., Henaghan, M. B. 1970. Need for achievement: Relation to academic achievement and inventoried needs. *J. Stud. Personnel Assoc. Teacher Educ.* 8:105–14
11. Ayers, J. B., Bashaw, W. L., Wash, J. A. 1969. A study of the validity of the Sixteen Personality Factor Questionnaire in predicting high school academic achievement. *Educ. Psychol. Meas.* 29:479–84
12. Bailey, S. T. 1970. Independence and factor structure of self-concept metadimensions. *J. Couns. Psychol.* 17:425–30
13. Baker, F. 1971. Measures of ego-identity: A multitrait-multimethod validation. *Educ. Psychol. Meas.* 31:165–73
14. Baldry, A. I., Sarason, I. G. 1968. Test anxiety, preliminary instructions, and responses to personality inventories. *J. Clin. Psychol.* 24:67
15. Barton, M. L. 1970. Extraversion, inhibition, and adaptation level theory: An unexpected finding. *Proc. 78th Ann. Conv. APA* 5:477–78
16. Bauman, M. J., Straughan, J. H. 1969. BSR as a function of anxiety, stress and sex. *Psychol. Rec.* 19:339–44
17. Bentler, P. M., Jackson, D. N., Messick, S. 1970. Identification of content and style: A two-dimensional interpretation of acquiescence. *Psychol. Bull.* 76:186–204
18. Bentler, P. M., Prince, C. 1970. Psychiatric symptomatology in transvestites. *J. Clin. Psychol.* 26:434–35
19. Berger, E. M. 1971. MMPI item differences between smoker and nonsmoker college freshmen males. *J. Consult. Clin. Psychol.* 36:446
20. Berlyne, D. E., Carey, S. T. 1968. Incidental learning and the timing of arousal. *Psychon. Sci.* 13:103–4
21. Bernhardson, C. S. 1970. Social desirability as a confounding variable in the reversed item approach to studying acquiescence in the MMPI. *Can. J. Behav. Sci.* 2:148–56
22. Bernhardson, C. S., Fisher, R. J. 1970. Perceptions of social desirability and frequency of occurrence of traits and the probability that the traits will be endorsed. *Percept. Mot. Skills* 30:571–76
23. Bhatnagar, R. P. 1969. A study of some EPPS variables as factors of academic achievement. *J. Appl. Psychol.* 53:107–11
24. Blackburn, R. 1968. The scores of Eysenck's criterion groups on some MMPI scales related to emotionality and extraversion. *Brit. J. Soc. Clin. Psychol.* 7:3–12
25. Blane, H., Yamamoto, K. 1970. Sexual role identity among Japanese and Japanese-American high school students. *J. Cross-Cult. Psychol.* 1:345–54
26. Block, J. 1971. On further conjectures regarding acquiescence. *Psychol. Bull.* 76:205–10
27. Blum, D. M. 1970. MMPI characteristics of males in a private hospital

population. *Psychol. Rep.* 26:234

28. Bock, R. D., Dicken, C., Van Pelt, J. 1969. Methodological implications of content-acquiescence correlation in the MMPI. *Psychol. Bull.* 71:127–39
29. Bone, R. N., Montgomery, D. D. 1970. Extraversion, neuroticism, and sensation seeking. *Psychol. Rep.* 26:974
30. Bonjean, C. M., Vance, G. G. 1968. A short-form measure of self-actualization. *J. Appl. Behav. Sci.* 4:299–312
31. Boruch, R. F., Larkin, J. D., Wolins, L. MacKinney, A. C. 1970. Alternative methods of analysis: Multitrait-multimethod data. *Educ. Psychol. Meas.* 30:833–53
32. Boruch, R. F., Wolins, L. 1970. A procedure for estimation of trait, method and error variance attributable to a measure. *Educ. Psychol. Meas.* 30:547–74
33. Boshier, R. 1968. Self esteem and first names in children. *Psychol. Rep.* 22:762
34. Bott, M. M. 1970. The M-F scale: Yesterday and today. *Meas. Eval. Guid.* 3:92–96
35. Bouchard, T. J. 1968. Convergent and discriminant validity of the Adjective Check List and Edwards Personal Preference Schedule. *Educ. Psychol. Meas.* 28:1165–71
36. Braun, J. R. 1970. Edwards Personality Inventory, Booklet IV: Faking and faking detection. *Meas. Eval. Guid.* 3:86–87
37. Braun, J. R., Asta, P. 1968. Intercorrelations between Personal Orientation Inventory and Gordon Personal Inventory scores. *Psychol. Rep.* 23:1197–98
38. Braun, J. R., Asta, P. 1969. Changes in Personality Research Form scores (PRF, Form A) produced by faking instructions. *J. Clin. Psychol.* 25:429–30
39. Braun, J. R., Asta, P. 1969. A comparison of "real" vs. "ideal" self with a self-actualization inventory, *J. Psychol.* 72:159–64
40. Braun, J. R., Asta, P. 1969. Faking and faking detection on the Minnesota Counseling Inventory. *Meas. Eval. Guid.* 2:25–31
41. Braun, J. R., Costantini, A. 1970. Faking and faking detection on the Personality Research Form, AA. *J. Clin. Psychol.* 26:516–18
42. Braun, J. R., Graziano, A. M., Boyko, E. 1970. A construct validity study of the Shallow Affect Scale. *J. Clin. Psychol.* 26:197–99
43. Braun, J. R., La Faro, D. 1968. Effects of salesmen faking instructions on the Contact Personality Factor Test. *Psychol. Rep.* 22: 1245–48
44. Braun, J. R., La Faro, D. 1969. A further study of the fakability of the Personal Orientation Inventory. *J. Clin. Psychol.* 25:296–99
45. Braun, J. R., La Faro, D. 1969. Faking and faking detection on the 16 PF-Form A. *J. Psychol.* 71:155–58
46. Braun, J. R., Tinley, J. J. 1970. Faking study of scores on the Self-Perception Inventory. *Psychol. Rep.* 26:118
47. Broadhurst, A., Glass, A. 1969. Relationship of personality measures to the alpha rhythm of the electroencephalogram. *Brit. J. Psychiat.* 115:199–204
48. Brown, S. R. 1968. Bibliography on Q technique and its methodology. *Percept. Mot. Skills* 26:587–613
49. Brown, W. P. 1970. Individual differences in associating to neutral and emotional words. *J. Consult. Clin. Psychol.* 34:33–36
50. Burnes, K., Brown, W. A., Keating, G. 1971. Dimensions of control: Correlations between MMPI and I-E Scores. *J. Consult. Clin. Psychol.* 36:301
51. Buros, O. K. 1970. *Personality Tests and Reviews.* Highland Park, N. J.: Gryphon. 1659 pp.
52. Burton, R. V. 1970. Validity of retrospective reports assessed by the multitrait-multimethod analysis. *Develop. Psychol.* 3(3): Part 2
53. Callahan, L. J., Wauck, L. A. 1969. Characteristics of a minor seminary population on the Edwards Personal Preference Schedule. *Nat. Cath. Guid. Conf. J.* 13:30–37
54. Campbell, D. T., Fiske, D. W. 1959. Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychol. Bull.* 56: 81–105.
55. Caracena, P. F., Vicory, J. R. 1969. Correlates of phenomenological and judged empathy. *J. Couns. Psychol.* 16:510–15
56. Carlson, R. 1970. On the structure of self-esteem: Comments on Ziller's formulation. *J. Consult. Clin. Psychol.* 34:264–68
57. Carlson, R. 1971. Where is the person

in personality research? *Psychol. Bull.* 75:203–19

58. Carlson, R., Levy, N. 1968. Brief method for assessing social-personal orientation. *Psychol. Rep.* 23:911–14
59. Carlson, R., Parker, J. 1969. Personality and esthetic sensitivity. *J. Proj. Tech. Pers. Assess.* 33:530–34
60. Carr, J. E. 1969. Instructional set and social desirability scale values. *Psychol. Rep.* 24:277–78
61. Carrier, N. A., Jewell, L. N. 1968. Splitting the Achievement Anxiety Test. *Stud. Higher Educ.* 95:22–27
62. Catalano, J. F., Berger, D. F. 1970. The effect of need for achievement and normative information on rotary pursuit performance. *Psychon. Sci.* 18:69–71
63. Cattell, R. B., Bolton, L. S. 1969. What pathological dimensions lie beyond the normal dimensions of the 16 PF? A comparison of MMPI and 16 PF factor domains. *J. Consult. Clin. Psychol.* 33:18–29
64. Cattell, R. B., Eber, H. W., Delhees, K. H. 1968. A large sample cross-validation of the personality trait structure of the 16 PF with some clinical implications. *Multivar. Behav. Res.* 3:107–31
65. Cattell, R. B., Warburton, F. W. 1967. *Objective Personality and Motivation Tests: A Theoretical Introduction and Practical Compendium.* Urbana: Univ. Illinois. 687 pp.
66. Chapman, J. L. 1971. Development and validation of a scale to measure empathy. *J. Couns. Psychol.* 18:281–82
67. Chinsky, J. M., Rappaport, J. 1970. Brief critique of the meaning and reliability of "accurate empathy" ratings. *Psychol. Bull.* 73:379–82
68. Chodorkoff, B., Cooke, G. 1970. Development of an inventory to measure psychosexual development. *Psychol. Rep.* 27:186
69. Chu, C. 1966. *Object cluster analysis of the MMPI.* PhD thesis. Univ. California, Berkeley. 141 pp.
70. Clemans, W. V. 1956. *An analytical and empirical examination of some properties of ipsative measures.* PhD thesis. Univ. Washington, Seattle. 100 pp.
71. Clemans, W. V. 1966. An analytical and empirical examination of some properties of ipsative measures. *Psychometrika, Monogr. Suppl. 14*
72. Collett, L. J., Lester, D. 1969. The fear of death and the fear of dying. *J. Psychol.* 72:179–81
73. Comrey, A. L. 1969. Personality factors, general activity, socialization, compulsion, and dependence. *Proc. 77th Ann. Conv. APA* 4:151–52
74. Comrey, A. L. 1970. *Manual for the Comrey Personality Scales.* San Diego: Educational and Industrial Testing Service. 40 pp.
75. Comrey, A. L., Backer, T. E. 1970. Construct validation of the Comrey Personality Scales. *Multivar. Behav. Res.* 5:469–77
76. Cone, J. D. 1971. Locus of control and social desirability. *J. Consult. Clin. Psychol.* 36:449
77. Conger, A. J. 1969. A dimensional analysis of MMPI items. *Multivar. Behav. Res.* 4:309–27
78. Conger, A. J. 1971. Evaluation of multimethod factor analysis. *Psychol. Bull.* 75:416–20
79. Connor, G. N., Boblitt, W. E. 1970. Reported frequency of dream recall as a function of intelligence and various personality test factors. *J. Clin. Psychol.* 26:438–39
80. Costin, F. 1969. The Scrambled Sentence Test: A group measure of hostility. *Educ. Psychol. Meas.* 29: 461–68
81. Cowden, J. E., Pacht, A. R., Bodemer, O. A. 1970. The 16 PF vs. the MCI in a group testing program of reformatory inmates. *J. Clin. Psychol.* 26:510–13
82. Crandall, J. E. 1969. Self-perception and interpersonal attraction as related to tolerance-intolerance of ambiguity. *J. Pers.* 37:127–40
83. Creaser, J. W., Little, E. B. 1969. Deriving a personality characteristic from test-taking behavior. *Psychol. Rep.* 25:877–78
84. Cronbach, L. J., Furby, L. 1970. How should we measure "change" —Or should we? *Psychol. Bull.* 74: 68–80
85. Cronbach, L. J., Meehl, P. E. 1955. Construct validity in psychological tests. *Psychol. Bull.* 52:281–302
86. Crookes, T. G., Pearson, P. R. 1970. The relationship between EPI scores and 16 PF second-order factors in a clinical group. *Brit. J. Soc. Clin. Psychol.* 9:189–90
87. Crookes, T. G., Pearson, P. R. 1970. WAIS IQ, Sixteen PF B score and

education. *J. Clin. Psychol.* 26: 348–49

88. Crowne, D. P., Marlowe, D. 1960. A new scale of social desirability independent of psychopathology. *J. Consult. Psychol.* 24:349–54

89. Crowne, D., Marlowe, D. 1964. *The Approval Motive: Studies in Evaluative Dependence.* New York: Wiley. 233 pp.

90. Culbert, S. A., Clark, J. V., Bobele, H. K. 1968. Measures of change toward self-actualization in two sensitivity training groups. *J. Couns. Psychol.* 15:53–57

91. Damarin, F. 1971. A special review of Buros' Personality Tests and Reviews. *Educ. Psychol. Meas.* 31: 215–41

92. Damm, V. J. 1969. Overall measures of self-actualization derived from the Personal Orientation Inventory. *Educ. Psychol. Meas.* 29: 977–81

93. Dana, R. H., Cocking, R. R. 1969. Repression-sensitization and Maudsley Personality Inventory scores: Response sets and stress effects. *Brit. J. Soc. Clin. Psychol.* 8:263–69

94. Danish, S. J., Kagan, N. 1971. Measurement of affective sensitivity: Toward a valid measure of interpersonal perception. *J. Couns. Psychol.* 18:51–54

95. Davidson, P. O., McDougall, C. E. 1969. Personality and pain tolerance measures. *Percept. Mot. Skills* 28:787–90

96. Davies, M. 1970. Blood pressure and personality. *J. Psychosom. Res.* 14: 89–104

97. Davis, K. R., Sines, J. O. 1971. An antisocial behavior pattern associated with a specific MMPI profile. *J. Consult. Clin. Psychol.* 36: 229–34

98. Dayries, J. L., Grimm, R. L. 1970. Personality traits of women athletes as measured by the Edwards Personal Preference Schedule. *Percept. Mot. Skills* 30:229–30

99. Delhees, K. H., Cattell, R. B. 1970. Obtaining 16 PF scores from the MMPI, and MMPI scores from the 16 PF. *J. Proj. Tech. Pers. Assess.* 34:251–55

100. Desiderato, P., Koskinen, P. 1969. Anxiety, study habits, and academic achievement. *J. Couns. Psychol.* 16:162–65

101. Dielman, T. E., Wilson, W. R. 1970. Convergent and discriminant validity of three measures of ability, aspiration-level, achievement, adjustment and dominance. *J. Educ. Meas.* 7:185–90

102. Dies, R. R. 1970. Need for social approval and blame assignment. *J. Consult. Clin. Psychol.* 35:311–16

103. Dies, R., Honeyman, M., Reznikoff, M., White, C. 1969. Personality and smoking patterns in a twin population. *J. Proj. Tech. Pers. Assess.* 33:457–63

104. Distefano, M. K. Jr., Pryer, M. W. 1970. Predicting vocational outcome of psychiatric patients with the Edwards Personal Preference Schedule. *J. Appl. Psychol.* 54: 552–54

105. Dixon, T. R. 1970. Experimenter approval, social desirability and statements of self-reference. *J. Consult. Clin. Psychol.* 35:400–5

106. Doctor, R. M., Altman, F. 1969. Worry and emotionality as components of test anxiety: Replication and further data. *Psychol. Rep.* 24: 563–68

107. Domino, G. 1968. Differential prediction of academic achievement in conforming and independent settings. *J. Educ. Psychol.* 59: 256–60

108. Domino, G. 1969. Maternal personality correlates of sons' creativity. *J. Consult. Clin. Psychol.* 33: 180–83

109. Ibid 1970. Identification of potentially creative persons from the Adjective Check List. 35:48–51

110. Drakeford, G. C. 1969. The EPI and scales of rigidity and dogmatism. *Brit. J. Soc. Clin. Psychol.* 8:9–12

111. Dreger, R. M. 1968. General temperament and personality factors related to intellectual performance. *J. Genet. Psychol.* 113:275–93

112. Dreger, R. M., Barnert, M. 1969. Measurement of the custom and conscience functions of the superego. *J. Soc. Psychol.* 77:269–80

113. Dubeck, J. A., Schuck, S. Z., Cymbalisty, B. 1971. Falsification of the forced-choice guilt inventory. *J. Consult. Clin. Psychol.* 36:296

114. Dublin, J. E., Elton, C. F., Berzins, J. I. 1969. Some personality and aptitudinal correlates of the "A-B" therapist scale. *J. Consult. Clin. Psychol.* 33:739–45

115. Duffy, K. E., Jamison, K., Comrey,

A. L. 1969. Assessment of a proposed expansion of the Comrey Personality Factor System. *Multivar. Behav. Res.* 4:295–307

116. Edwards, A. L. 1957. *The Social Desirability Variable in Personality Assessment and Research.* New York: Holt. 108 pp.
117. Edwards, A. L. 1959. Social desirability and the description of others. *J. Abnorm. Soc. Psychol.* 59:434–36
118. Edwards, A. L. 1969. Correlations between scores on personality scales when items are stated in the first and third person form. *Educ. Psychol. Meas.* 29:561–63
119. Ibid. Trait and evaluative consistency in self-description, 737–52
120. Edwards, A. L. 1970. *The Measurement of Personality Traits by Scales and Inventories.* New York: Holt. 306 pp.
121. Edwards, A. L., Abbott, R. D. 1969. Further evidence regarding the R scale of the MMPI as a measure of acquiescence. *Psychol. Rep.* 24: 903–6
122. Edwards, A. L., Abbott, R. D. 1972. Relationships between the EPI scales and the 16 PF, CPI, and EPPS scales. *Educ. Psychol. Meas.* In press
123. Edwards, A. L., Abbott, R. D. 1972. Relationships between the EPI scales and the EPPS and PRF scales. *J. Consult. Clin. Psychol.* In press
124. Edwards, A. L., Abbott, R. D., Klockars, A. J. 1970. Social desirability and the TSC scales: A replication and reply to Stein. *Multivar. Behav. Res.* 5:325–27
125. Edwards, A. L., Abbott, R. D., Klockars, A. J. 1972. A factor analysis of the EPPS and PRF personality inventories. *Educ. Psychol. Meas.* 32:23–29
126. Edwards, A. L., Cone, J. D., Abbott, R. D. 1970. Anxiety, structure, or social desirability? *J. Consult. Clin. Psychol.* 34:236–38
127. Edwards, A. L., Diers, C. J., Walker, J. N. 1962. Response sets and factor loadings on sixty-one personality scales. *J. Appl. Psychol.* 46: 220–25
128. Edwards, A. L., Klockars, A. J., Abbott, R. D. 1970. Social desirability and the TSC MMPI scales. *Multivar. Behav. Res.* 5:153–56
129. Ehrlich, H. J., Lee, D. 1969. Dogmatism, learning, and resistance to change: A review and a new paradigm. *Psychol. Bull.* 71:249–60
130. Elton, C. F. 1969. Patterns of change in personality test scores. *J. Couns. Psychol.* 16:95–99
131. Elton, C. F. 1970. Personality of low income males: College versus noncollege. *J. Coll. Stud. Personnel* 11: 210–12
132. Elton, C. F., Rose, H. A. 1969. Personality assessments compared with personality inferred from occupational choices. *J. Couns. Psychol.* 16:329–44
133. Elton, C. F., Terry, T. R. 1969. Factor stability of the Omnibus Personality Inventory. *J. Couns. Psychol.* 16:373–74
134. Endler, N. S., Hunt, J. M. 1968. S-R Inventories of Hostility and comparisons of the proportions of variance from persons, responses, and situations for hostility and anxiousness. *J. Pers. Soc. Psychol.* 9:309–15
135. Endler, N. S., Hunt, J. M. 1969. Generalizability of contributions from sources of variance in the S-R Inventories of Anxiousness. *J. Pers.* 37:1–24
136. Entwistle, N. J., Entwistle, D. 1970. The relationships between personality, study methods, and academic performance. *Brit. J. Educ. Psychol.* 40:132–43
137. Evans, R. B. 1970. Sixteen Personality Questionnaire scores of homosexual men. *J. Consult. Clin. Psychol.* 34:212–15
138. Eysenck, H. J., Eysenck, S. B. 1969. *Personality Structure and Measurement.* San Diego: Knapp. 365 pp.
139. Eysenck, S. B., Eysenck, H. J. 1969. Scores on three personality variables as a function of age, sex, and social class. *Brit. J. Soc. Clin. Psychol.* 8:69–76
140. Farley, F. H. 1970. Comparability of the MPI and EPI on normal subjects. *Brit. J. Soc. Clin. Psychol.* 9: 74–76
141. Ibid. Further investigation of the two personae of extraversion, 377–79
142. Farley, F. H., Farley, S. V. 1970. Impulsiveness, sociability, and the preference for varied experience. *Percept. Mot. Skills* 31:47–50
143. Faunce, P. S. 1968. Personality characteristics and vocational interests related to the college persistence of

academically gifted women. *J. Couns. Psychol.* 15:31–40

144. Felipe, A. I. 1970. Evaluative versus descriptive consistency in trait inferences. *J. Pers. Soc. Psychol.* 16:627–38

145. Ferguson, L. W. 1970. An index of self-allocation on a cold-warm personality dimension. *Percept. Mot. Skills* 30:787–93

146. Finney, J. C. 1968. Normative data on some MMPI scales. *Psychol. Rep.* 23:219–29

147. Fisher, G., Silverstein, A. B. 1969. Simulation of poor adjustment on a measure of self-actualization. *J. Clin. Psychol.* 25:198–99

148. Fisher, M. D., Haddox, V. G., Jacobson, M. D. 1969. Multitrait-multimethod analysis of the validity of the Clyde Mood Scale. *Proc. 77th Ann. Conv. APA* 4:129–30

149. Fiske, D. W. 1969. Subject reactions to inventory format and content. *Proc. 77th Ann. Conv. APA* 4: 137–38

150. Fiske, D. W. 1971. *Measuring the Concepts of Personality.* Chicago: Aldine. 322 pp.

151. Fiske, D. W., Pearson, P. H. 1970. Theory and techniques of personality measurement. *Ann. Rev. Psychol.* 21:49–86

152. Ford, L. H., Rubin, B. M. 1970. A social desirability questionnaire for young children. *J. Consult. Clin. Psychol.* 35:195–204

153. Foulds, M. L., Warehime, R. G. 1971. Relationship between repression-sensitization and a measure of self-actualization. *J. Consult. Clin. Psychol.* 36:257–59

154. Foulds, M. L., Warehime, R. G. 1971. Effects of a "fake good" response set on a measure of self-actualization. *J. Couns. Psychol.* 18:279–80

155. Fowler, R. D., Coyle, F. A. 1969. MMPI characteristics of freshmen entering college. *Psychol. Rec.* 19: 263–71

156. Fox, J., Knapp, R. R., Michael, W. B. 1968. Assessment of self-actualization of psychiatric patients: Validity of the Personal Orientation Inventory. *Educ. Psychol. Meas.* 28:565–69

157. Francis, R. D. 1969. Neuroticism and optical pupil changes in response to auditory stimuli. *Brit. J. Soc. Clin. Psychol.* 8:344–49

158. Fricke, B. G. 1970. OAIS scores of University of Amsterdam students: Invalidity of high infrequent response scale scores. *Proc. 78th Ann. Conv. APA* 5:173–74

159. Frost, B. P. 1970. A note on extraversion and aggression. *West. Psychol.* 1:111–12

160. Galbraith, G. G. 1969. The Mosher Sex-Guilt scale and the Thorne Sex Inventory: Intercorrelations. *J. Clin. Psychol.* 25:292–94

161. Galbraith, G. G., Hahn, K., Leiberman, H. 1968. Personality correlates of free-associative sex responses to double entendre words. *J. Consult. Clin. Psychol.* 32:193–97

162. Gale, A., Coles, M., Blaydon, J. 1969. Extraversion-introversion and the EEG. *Brit. J. Psychol.* 60: 209–23

163. Gallessich, J. 1970. An investigation of correlates of academic success of freshmen engineering students. *J. Couns. Psychol.* 17:173–76

164. Garside, R. F., Kay, D. W., Roy, J. R., Beamish, P. 1970. MPI scores and symptoms of depression. *Brit. J. Psychiat.* 116:429–32

165. Gayton, W., Bernstein, S. 1969. Incompatible need strength and the repression-sensitization dimension. *J. Clin. Psychol.* 25:192–94

166. Geen, R. G., George, R. 1969. Relationship of manifest aggressiveness to aggressive word associations. *Psychol. Rep.* 25:711–14

167. Gleser, G. C., Ihilevich, D. 1969. An objective instrument for measuring defense mechanisms. *J. Consult. Clin. Psychol.* 33:51–60

168. Goldberg, L. R. 1971. A historical survey of personality scales and inventories. In *Advances in Psychological Assessment*, ed. P. McReynolds, 2:293–336. Palo Alto: Science and Behavior Books. 395 pp.

169. Goldstein, S. G., Linden, J. D. 1969. Multivariate classification of alcoholics by means of the MMPI. *J. Abnorm. Psychol.* 74:661–69

170. Golightly, C., Reinehr, R. C. 1969. 16 PF profiles of hospitalized alcoholic patients: Replication and extension. *Psychol. Rep.* 24:543–45

171. Golin, S., Herron, E. W., Lakota, R., Reineck, L. 1967. Factor analytic study of the manifest anxiety, extraversion, and repression-sensitization scales. *J. Consult. Clin. Psychol.* 31:564–69

172. Goodman, P., Furcon, J., Rose, J.

1969. Examination of some measures of creative ability by the multitrait-multimethod matrix. *J. Appl. Psychol.* 53:240–43

173. Goodstein, L. D., Lanyon, R. I., Eds. 1971. *Readings in Personality Assessment.* New York: Wiley. 792 pp.

174. Goodwin, K. S., Schaie, K. W. 1969. Age differences in personality structure. *Proc. 77th Ann. Conv. APA* 4:713–14

175. Goorney, A. B. 1970. MPI and MMPI scores, correlations and analysis for a military aircrew population. *Brit. J. Soc. Clin. Psychol.* 9:164–70

176. Gordon, L. V. 1969. Q-typing: An exploration in personality measurement. *J. Soc. Psychol.* 78:121–36

177. Gorman, B. S. 1968. Social desirability factors and the Eysenck Personality Inventory. *J. Psychol.* 69:75–83.

178. Gorman, B. S. 1970. 16 PF correlates of sensation-seeking. *Psychol. Rep.* 26:741–42

179. Goss, A. 1968. Edwards Personal Preference Schedule patterns in psychiatric populations. *J. Proj. Tech. Pers. Assess.* 32:173–76

180. Goss, A., Morosko, T. E. 1969. Alcoholism and clinical symptoms. *J. Abnorm. Psychol.* 74:682–84

181. Gough, H. G. 1969. A leadership index on the California Psychological Inventory. *J. Couns. Psychol.* 16:283–89

182. Gough, H. G., Chun, K., Chung, Y. 1968. Validation of the CPI Femininity scale in Korea. *Psychol. Rep.* 22:155–60

183. Graff, R. W. et al 1970. The POI: A validity check. *Educ. Psychol. Meas.* 30:429–32

184. Gravitz, M. A. 1968. Self-described depression and scores on the MMPI D scale in normal subjects. *J. Proj. Tech. Pers. Assess.* 32:88–91

185. Gray, B. G., Gynther, M. D. 1970. Favorability ratings of MMPI sex items: Stimulus pull or social interaction effects? *J. Proj. Tech. Pers. Assess.* 34:245–50

186. Greenwald, H. J., Clausen, J. D. 1970. Test of relationship between yea-saying and social desirability. *Psychol. Rep.* 27:139–41

187. Griffith, A. V., Trogdon, K. P. 1969. Self-expressive styles among college students preparing for careers in nursing and music. *J. Couns. Psychol.* 16:275–77

188. Gunderson, M. M. 1969. Relationships between expressed personality needs and social background and military status variables. *J. Psychol.* 71:217–24

189. Gynther, M. D., Gray, B. G., Strauss, M. E. 1970. Effects of religious affiliation, religious involvement, and sex on the social desirability ratings of MMPI religion items. *J. Consult. Clin. Psychol.* 34:338–42

190. Haertzen, C. A. 1969. Implications of Eysenck's criterion analysis for test construction: Is the MMPI schizophrenia scale a criterion for schizophrenia? *Psychol. Rep.* 24:894

191. Hain, J. D., Linton, P. H., Eber, H. W., Chapman, M. M. 1970. Menstrual irregularity, symptoms, and personality. *J. Psychosom. Res.* 14:81–87

192. Hamilton, D. L. 1968. Personality attributes associated with extreme response style. *Psychol. Bull.* 69:192–203

193. Hamilton, D. L. 1969. Responses to cognitive inconsistencies: Personality, discrepancy level, and response stability. *J. Pers. Soc. Psychol.* 11:351–62

194. Hamilton, D. L. 1971. A comparative study of five methods of assessing self-esteem, dominance, and dogmatism. *Educ. Psychol. Meas.* 31:441–52

195. Handal, P. J. 1969. The relationship between subjective life expectancy, death anxiety and general anxiety. *J. Clin. Psychol.* 25:39–42

196. Harris, R. J., Wittner, W., Koppell, B., Hilf, F. D. 1970. MMPI scales versus interviewer ratings of paranoia. *Psychol. Rep.* 27:447–50

197. Harrison, R. H., Kass, E. H. 1968. MMPI correlates of Negro acculturation in a northern city. *J. Pers. Soc. Psychol.* 10:262–70

198. Heise, D. R. 1969. Some methodological issues in semantic differential research. *Psychol. Bull.* 72:406–22

199. Hettich, P. I., Walker, R. E. 1970. Effects of experimenter absence and subject briefing on social desirability scale scores. *J. Consult. Clin. Psychol.* 35:372–75

200. Hicks, J. M., Wright, J. H. 1970.

Convergent-discriminant validation and factor analysis of five scales of liberalism-conservatism. *J. Pers. Soc. Psychol.* 14:114–20

201. Hicks, L. E. 1970. Some properties of ipsative, normative, and forced-choice normative measures. *Psychol. Bull.* 74:167–84
202. Higgins, J. 1970. Personality correlates of the Goodman Socio-Sexual Adjustment scale. *J. Abnorm. Psychol.* 75:276–77
203. Hiner, D. L., Ogren, D. J., Baxter, J. C. 1969. Ideal-self responding on the MMPI. *J. Proj. Tech. Pers. Assess.* 33:389–96
204. Hoffman, H. 1968. Performance on the Personality Research Form under desirable and undesirable instructions: Personality disorders. *Psychol. Rep.* 23:507–10
205. Ibid 1970. Note on the personality traits of student nurses. 27:1004
206. Hofstee, W. K. 1969. Method effects in judging the desirability of traits. *Educ. Psychol. Meas.* 29:583–604
207. Hogan, R. 1969. Development of an empathy scale. *J. Consult. Clin. Psychol.* 33:307–16
208. Hollender, J. W. 1969. Conflict in defensive males as a function of diagnostic expertise and undesirable personality interpretations. *J. Exp. Res. Pers.* 4:51–56
209. Holmes, D. S. 1969. Sensing humor: Latency and amplitude of response related to MMPI profiles. *J. Consult. Clin. Psychol.* 33:296–301
210. Ibid 1971. Conscious self-appraisal of achievement motivation: The self-peer rank method revisited. 36:23–36
211. Holmes, D. S., Tyler, J. D. 1968. Direct versus projective measurement of achievement motivation. *J. Consult. Clin. Psychol.* 32:712–17
212. Holt, R. R. 1971. *Assessing Personality.* New York: Harcourt, Brace, Jovanovich. 245 pp.
213. Horst, A. P. 1965. *Factor Analysis of Data Matrices.* New York: Holt. 730 pp.
214. Horton, M., Kriauciunas, R. 1970. Minnesota Multiphasic Personality Inventory differences between terminators and continuers in youth counseling. *J. Couns. Psychol.* 17:98–102
215. Howarth, E. 1968. Personality differences in serial learning under distraction. *Percept. Mot. Skills* 28:379–82
216. Howarth, E. 1969. Expectations concerning occupations in relation to extraversion-introversion. *Psychol. Rep.* 24:415–18
217. Howarth, E., Browne, J. A. 1971. An item factor analysis of the 16 PF. *Personality: Int. J.* 2:117–39
218. Howarth, E., Browne, J. A. 1971. Investigation of personality factors in a Canadian context: I. Marker structure in personality questionnaire items. *Can. J. Behav. Sci.* 3:161–73
219. Howarth, E., Eysenck, H. J. 1968. Extraversion, arousal, and paired-associate recall. *J. Exp. Res. Pers.* 3:114–16
220. Howarth, E., Skinner, N. F. 1969. Salivation as a physiological indicator of introversion. *J. Psychol.* 73:223–28
221. Hundal, P. S., Singh, A., Singh, M. 1970. Factor analytical study of tests of anxiety. *Psychol. Rep.* 26:875–78
222. Hundleby, J. D., Connor, W. H. 1968. Interrelationships between personality inventories: The 16 PF, the MMPI, and the MPI. *J. Consult. Clin. Psychol.* 32:152–57
223. Hurley, J., Hurley, S. 1969. Toward authenticity in measuring self-disclosure. *J. Couns. Psychol.* 16:271–74
224. Ilardi R. L., May, W. T. 1968. A reliability study of Shostrom's Personal Orientation Inventory. *J. Hum. Psychol.* 8:68–72
225. Ivanoff, J. M., Layman, J. A., Von Singer, R. 1970. Changes in ACL scales corresponding to changes in educational levels. *Psychol. Rep.* 27:359–63
226. Iwawaki, S., Zax, M. 1969. Personality dimensions and extreme response tendency. *Psychol. Rep.* 25:31–34
227. Jackson, D. N. 1969. Multimethod factor analysis in the evaluation of convergent and discriminant validity. *Psychol. Bull.* 72:30–49
228. Jackson, D. N. 1971. The dynamics of structured personality tests: 1971. *Psychol. Rev.* 78:229–48
229. Jackson, D. N. 1971. Comments on "Evaluation of multimethod factor analysis." *Psychol. Bull.* 75:421–23
230. Jackson, D. N., Carlson, K. A.

1969. Convergent and discriminant validation of the Differential Personality Inventory. *Univ. West. Ontario Res. Bull.* 129

231. Jackson, D. N., Messick, S. 1969. A distinction between judgments of frequency and of desirability as determinants of response. *Educ. Psychol. Meas.* 29:273–93

232. Jamison, K., Comrey, A. L. 1968. Further study of dependence as a personality factor. *Psychol. Rep.* 22:239–42

233. Jamison, K., Comrey, A. L. 1969. A comparison of personality factor structure in British and American university students. *J. Psychol.* 71: 45–57

234. Jenkin, N., Vroegh, K. 1969. Contemporary concepts of masculinity and femininity. *Psychol. Rep.* 25: 679–97

235. Jenkins, C. D. et al 1969. Psychological traits and serum lipids. *Psychosom. Med.* 31: 115–28

236. Jewell, L. N. 1968. Differential responding to anxiety: Are there "facilitators" and "debilitators"? *Stud. Higher Educ.* 95:28–45

237. Joe, V. C. 1971. Review of the internal-external control construct as a personality variable. *Psychol. Rep.* 28:619–40

238. Jöreskog, K. G. 1971. Statistical analysis of sets of congeneric tests. *Psychometrika* 36:109–34

239. Julian, T., Metcalfe, M., Coppen, A. 1969. Aspects of personality of depressive patients. *Brit. J. Psychiat.* 115:587–89

240. Karson, S., Haupt, T. D. 1968. Second-order personality factors in parents of child guidance clinic patients. *Multivar. Behav. Res.* 3: 97–106

241. Kavanagh, M. J., MacKinney, A. C., Wolins, L. 1971. Issues in managerial performance: Multitrait-multimethod analyses of ratings. *Psychol. Bull.* 75:34–49

242. Kear-Colwell, J. J. 1970. The B factor scale of the 16 PF as a measure of intelligence in psychiatric patients. *J. Clin. Psychol.* 26:477–79

243. Kimble, G. A., Posnick, G. M. 1967. Anxiety? *J. Pers. Soc. Psychol.* 7: 108–10

244. Kincannon, J. C. 1968. Prediction of the standard MMPI scale scores from 71 items: The Mini-Mult. *J. Consult. Clin. Psychol.* 32:319–25

245. Kirby, D., Gardner, R. 1971. Norms on 208 words typically used in the assessment of ethnic stereotypes. *Univ. West. Ontario Res. Bull.* 177

246. Kish, G. B., Donnenwerth, G. V. 1969. Interests and stimulus seeking. *J. Couns. Psychol.* 16:551–56

247. Klavetter, R. E., Mogar, R. E., Watt, J. 1970. Changes on the Myers-Briggs following psychedelic therapy: A pilot study. *Psychol. Rep.* 26:510

248. Knott, P. D. 1970. A further methodological study of the measurement of interpersonal aggression. *Psychol. Rep.* 26:807–9

249. Kohfeld, D. L., Weitzel, W. 1969. Some relations between personality factors and social facilitation. *J. Exp. Res. Pers.* 3:287–92

250. Kohlan, R. G. 1968. Relationships between inventoried interests and inventoried needs. *Personnel Guid. J.* 46:592–98

251. Kokosh, J. 1969. MMPI personality characteristics of physical and social science students. *Psychol. Rep.* 24:883–93

252. Koppel, M. A., Sechrest, L. 1970. A multitrait-multimethod matrix analysis of sense of humor. *Educ. Psychol. Meas.* 30:77–85

253. Kramer, E., Aronovitch, C. D. 1970. Voice expression and rated extraversion. *J. Proj. Tech. Pers. Assess.* 34:426–27

254. Krop, H. 1969. Effects of extrinsic motivation, intrinsic motivation, and intelligence on creativity: A factorial approach. *J. Gen. Psychol.* 80:259–66

255. Kusyszyn, I., Jackson, D. N. 1968. A multimethod factor analytic appraisal of endorsement and judgment methods in personality assessment. *Educ. Psychol. Meas.* 28:1047–61

256. Lacks, P. B. 1970. Further investigation of the Mini-Mult. *J. Consult. Clin. Psychol.* 35:126–27

257. Lacks, P. B., Powell, B. J. The Mini-Mult as a personnel screening technique: A preliminary report. *Psychol. Rep.* 27:909–10

258. Lange, D. E. 1970. Validation of the orthogonal dimensions underlying the ICL and the octant constellations assumed to be their measure. *J. Proj. Tech. Pers. Assess.* 34: 519–27

259. Langston, R. D. 1970. The MMPI

and perseverance in the convent. *Psychol. Rep.* 27:811–14

260. Lanyon, R. I., Drotar, D. 1968. Response sets as personality concepts. *Psychol. Rep.* 23:751–56

261. Lanyon, R. I., Goodstein, L. D. 1971. *Personality Assessment.* New York: Wiley. 267 pp.

262. Larsen, K. 1971. Aggression-altruism: A scale and some data on its reliability and validity. *J. Pers. Assess.* 35:275–81

263. Lazzaro, T. A., Beggs, D. L., McNeil, K. A. 1969. The development and validation of the Self-Report Test of Impulse Control. *J. Clin. Psychol.* 25:434–38

264. Lebovits, B. Z., Ostfeld, A. M. 1970. Personality defensiveness and educational achievement: II. The Cattell 16 PF Questionnnaire. *J. Clin. Psychol.* 26:183–88

265. Lefcourt, H. M. 1966. Internal versus external control of reinforcement: A review. *Psychol. Bull.* 65:206–20

266. Leff, J. P. 1968. Perceptual phenomena and personality in sensory deprivation. *Brit. J. Psychiat.* 114:1499–1508

267. LeMay, M. L. 1969. Self-actualization and college achievement at three ability levels. *J. Couns. Psychol.* 16:582–83

268. LeMay, M. L., Damm, V. J. 1969. Relationship of the Personal Orientation Inventory to the Edwards Personal Preference Schedule. *Psychol. Rep.* 24:834

269. Leventhal, A. M. 1968. Additional technical data on the CPI Anxiety scale. *J. Couns. Psychol.* 15:479–80

270. Leventhal, G. S. 1970. Influence of brothers and sisters on sex-role behavior. *J. Pers. Soc. Psychol.* 16:452–65

271. Lewinsohn, P. M. 1968. Characteristics of patients with hallucinations, *J. Clin. Psychol.* 24:423

272. Liberty, P. G., Lunneborg, C. E., Atkinson, G. C. 1964. Perceptual defense, dissimulation, and response styles. *J. Consult. Psychol.* 28:529–37

273. Lieberman, L. R. 1969. Willingness to accept limitations and personal adjustment. *Percept. Mot. Skills* 29:425–26

274. Lin, Y.-G., McKeachie, W. J. 1970. Aptitude, anxiety, study habits, and academic achievement. *J. Couns. Psychol.* 17:306–9

275. Lombardi, D. N., O'Brien, B. J., Isele, F. W. 1968. Differential responses of addicts and nonaddicts on the MMPI. *J. Proj. Tech. Pers. Assess.* 32:479–82

276. Lorr, M. 1968. A test of seven MMPI factors. *Multivar. Behav. Res.* 3:151–56

277. Lorr, M., Hamlin, R. 1971. A multimethod factor analysis of behavioral and objective measures of psychopathology. *J. Consult. Clin. Psychol.* 36:136–41

278. Lunneborg, P. W. 1970. Stereotypic aspect in masculinity-femininity measurement. *J. Consult. Clin. Psychol.* 34:113–18

279. Lunneborg, P. W. 1970. EPPS patterns and academic achievement in counseling clients. *Educ. Psychol. Meas.* 30:393–98

280. Lunneborg, P. W., Lunneborg, C. E. 1970. Factor structure of MF scales and items. *J. Clin. Psychol.* 26:360–66

281. Lynn, R. 1969. An achievement motivation questionnaire. *Brit. J. Psychol.* 60:529–34

282. MacDonald, A. P. 1970. Revised scale for ambiguity tolerance: Reliability and validity. *Psychol. Rep.* 26:791–98

283. Manosevitz, M. 1970. Item analyses of the MMPI Mf scale using homosexual and heterosexual males. *J. Consult. Clin. Psychol.* 35:395–99

284. Martin, W. T. 1968. Self-Perception Inventory: A new test of personality. *Psychol. Rep.* 23:961–62

285. Mason, E. P., Adams, H. L., Blood, D. F. 1968. Further study of personality characteristics of bright college freshmen. *Psychol. Rep.* 23:395–400

286. Matell, M., Smith, R. E. 1970. Approval motive and academic behaviors: The self-reinforcement hypothesis. *J. Consult. Clin. Psychol.* 35:229–32

287. McBride, L., Moran, G. 1969. Double agreement as a positive function of approval dependence. *J. Soc. Psychol.* 78:75–79

288. McClain, E. W. 1970. Further validation of the Personal Orientation Inventory: Assessment of self-actualization of school counselors. *J. Consult. Clin. Psychol.* 35:21–22

289. McClain, E. W. 1970. Personality correlates of church attendance. *J. Coll. Stud. Personnel* 11:360–65

290. McClain, E. W., Andrews, H. B.

1969. Some personality correlates of peak experiences: A study in self-actualization. *J. Clin. Psychol.* 25:36–38

291. McClelland, J. N., Rhodes, F. 1969. Prediction of job success for hospital aides and orderlies from MMPI scores and personal history data. *J. Appl. Psychol.* 53:49–54
292. McDonald, R. L. 1968. Leary's overt interpersonal behavior: A validation attempt. *J. Soc. Psychol.* 74:259–64
293. McKeachie, W. J. 1969. Interaction of achievement cues and facilitating anxiety in the achievement of women. *J. Appl. Psychol.* 53: 147–48
294. McLaughlin, R. J. 1968. Retention in paired-associate learning related to extroversion and neuroticism. *Psychon. Sci.* 13:333–34
295. Megargee, E. I. 1969. Conscientious objectors' scores on the MMPI overcontrolled hostility scale. *Proc. 77th Ann. Conv. APA* 4:507–8
296. Megargee, E. I., Parker, G. V. 1968. An exploration of the equivalence of Murrayan needs as assessed by the Adjective Check List, the TAT and Edwards Personal Preference Schedule. *J. Clin. Psychol.* 24: 47–51
297. Mehrabian, A. 1969. Measures of achieving tendency. *Educ. Psychol. Meas.* 29:445–51
298. Ibid 1970. The development and validation of measures of affiliative tendency and sensitivity to rejection. 30:417–28
299. Mehrabian, A., Ksionzky, S. 1970. Models for affiliative and conforming behavior. *Psychol. Bull.* 74:110–26
300. Meisels, M., Canter, F. M. 1970. Personal space and personality characteristics: A non-confirmation. *Psychol. Rep.* 27:287–90
301. Meredith, G. M. 1968. Stereotypic desirability profiles for the 16 PF questionnaire. *Psychol. Rep.* 23: 1173–74
302. Merrens, M. 1970. Generality and stability of extreme response styles. *Psychol. Rep.* 27:802
303. Mikesell, R. H., Calhoun, L. G. 1969. Faking on the Zung Self-Rating Depression Scale. *Psychol. Rep.* 25:173–74
304. Mikesell, R. H., Calhoun, L. G. 1970. Response set on the Zung Self-Rating Depression Scale. *Percept. Mot. Skills* 30:22
305. Miklich, D. R. 1968. A test of the defensiveness interpretation of the Marlowe-Crowne scale. *Educ. Psychol. Meas.* 28:1193–96
306. Milburn, T. W., Bell, N., Koeske, G. F. 1970. Effect of censure or praise and evaluative dependence on performance in a free-learning task. *J. Pers. Soc. Psychol.* 15: 43–47
307. Millimet, C. R. 1970. Manifest anxiety-defensiveness scale: First factor of the MMPI revisited. *Psychol. Rep.* 27:603–16
308. Mirels, H. L., Garrett, J. B. 1971. The Protestant ethic as a personality variable. *J. Consult. Clin. Psychol.* 36:40–44
309. Mischel, W. 1968. *Personality and Assessment*. New York: Wiley. 365 pp.
310. Morgenson, D. F., Martin, I. 1969. Personality, awareness, and autonomic conditioning. *Psychophysiology* 5:536–47
311. Morris, B. B. 1968. Cross-validation of the Gordon SIV. *Percept. Mot. Skills* 27:44–46
312. Morrison, D., Centers, L. 1969. Investigation of the convergent validity of different measures of cognitive style. *J. Proj. Tech. Pers. Assess.* 33:168–72
313. Mosher, D. L. 1968. Measurement of guilt in females by self-report inventories. *J. Consult. Clin. Psychol.* 32:690–95
314. Norman, R. D., Fenson, J. N. 1970. Further aspects of construct validity of the Zuckerman Sensation-Seeking Scale. *J. Psychol.* 74: 131–40
315. Norman, R. P. 1969. Extreme response tendency as a function of emotional adjustment and stimulus ambiguity. *J. Consult. Clin. Psychol.* 33:406–10
316. Norman, W. T. 1969. "To see ourseles as ithers see us!": Relations among self-perceptions, peer-perceptions, and expected peer-perceptions of personality attributes. *Multivar. Behav. Res.* 4:417–43
317. Oakland, J. A. 1969. Personality structure of adolescents as measured by the Edwards Personality Inventory. *Psychol. Rep.* 24:215–23
318. Oakland, J. A. 1969. Measurement of personality correlates of academic achievement in high school

students. *J. Couns. Psychol.* 16: 452–57

319. O'Dell, J. W., Karson, S. 1969. Some relationships between the MMPI and 16 PF. *J. Clin. Psychol.* 25: 279–83
320. Orwin, W. 1969. Escape and avoidance learning in extremely neurotic and extremely stable subjects. *Brit. J. Soc. Clin. Psychol.* 8: 362–74
321. Osipow, S. H., Kreinbring, I. 1971. Temporal stability of an inventory to measure test anxiety. *J. Couns. Psychol.* 18:152–54
322. Ozehosky, J. R., McCarthy, J. B., Clark, E. T. 1970. Manifest needs among ROTC and non-ROTC undergraduates. *Psychol. Rep.* 26: 299–301
323. Parker, G. V. 1969. Sex differences in self-description on the Adjective Check List. *Educ. Psychol. Meas.* 29:99–113
324. Parker, G. V., Veldman, D. J. 1969. Item factor structure of the Adjective Check List. *Educ. Psychol. Meas.* 29:605–13
325. Parloff, M., Datta, L., Kleman, M., Handlon, J. 1968. Personality characteristics which differentiate creative male adolescents and adults. *J. Pers.* 36:528–52
326. Parsonson, B. S. 1969. Sex differences in the extreme response tendencies of psychiatric patients: A function of sex-role identification. *Psychol. Rep.* 25:871–76
327. Partington, J. T., Johnson, F. 1969. Personality types among alcoholics. *Quart. J. Stud. Alc.* 30: 21–34
328. Pasewark, R. A., Davis, F. G., Fitzgerald, B. J. 1968. Utilization of the Edwards Personal Preference Schedule with disturbed adolescents. *J. Clin. Psychol.* 24:451
329. Payne, I. R., Rasmussen, D. M., Shinedling, M. 1970. Characteristics of obese university females who lose weight. *Psychol. Rep.* 27:567–70
330. Peabody, D. 1967. Trait inferences: Evaluative and descriptive aspects. *J. Pers. Soc. Psychol. Monogr. Suppl.* 7: No. 4 (Whole No. 644)
331. Peabody, D. 1970. Evaluative and descriptive aspects in personality perception: A reappraisal. *J. Pers. Soc. Psychol.* 16:639–46
332. Pearson, P. H. 1970. Relationships between global and specified measures of novelty seeking. *J. Consult. Clin. Psychol.* 34:199–204
333. Persons, R. W. 1970. The Mosher Guilt Scale: Theoretical formulation, research review and normative data. *J. Proj. Tech. Pers. Assess.* 34:266–70
334. Pervin, L. A. 1970. *Personality: Theory, Assessment, and Research.* New York: Wiley. 632 pp.
335. Philip, A. E. 1969. The development and use of the Hostility and Direction of Hostility Questionnaire. *J. Psychosom. Res.* 13: 283–87
336. Pierce, R. A. 1970. Need similarity and complementarity as determinants of friendship choice. *J. Psychol.* 70:231–38
337. Piers, E. V., Kirchner, E. P. 1969. Eyelid conditioning and personality: Positive results from nonpartisans. *J. Abnorm. Psychol.* 74:336–39
338. Platman, S. R., Plutchik, R. 1970. Eysenck Personality Inventory as a mood test with manic-depressive patients. *Psychol. Rep.* 27:947–52
339. Platt, J. J., Eisenman, R., Darbes, A. 1970. Self-esteem and internal-external control: A validation study. *Psychol. Rep.* 26:162
340. Poe, C. A. 1969. Convergent and discriminant validation of measures of personal needs. *J. Educ. Meas.* 6:103–8
341. Power, R. P. 1968. Simulation of stable and neurotic personalities by subjects warned of the presence of Lie scales in inventories. *Brit. J. Psychol.* 59:105–9
342. Power, R. P., O'Donovan, D. 1969. Detection of simulation on the MPI by subjects given the rationale of the lie scale. *Brit. J. Psychol.* 60:535–41
343. Power, R. P., Thompson, W. T. 1970. Simulation of introversion and extraversion on the lemon test. *Brit. J. Psychol.* 61:91–93
344. Pryer, M. W., Distefano, M. K. Jr. 1970. Further evaluation of the EPPS with hospitalized alcoholics. *J. Clin. Psychol.* 26:205
345. Quereshi, M. Y. 1970. The development of the Michill Adjective Rating Scale (MARS). *J. Clin. Psychol.* 26:192–96
346. Radcliffe, J. A. 1963. Some properties of ipsative score matrices and their relevance for some current interest tests. *Aust. J. Psychol.* 15:1–11

347. Ramsay, R. W. 1969. Salivary response and introversion-extraversion. *Acta Psychol. Amst.* 29: 181–87

348. Ray, W. J., Katahn, M. 1968. Relation of anxiety to locus of control. *Psychol. Rep.* 23:1196

349. Reiter, H. H. 1970. Similarities and differences in scores on certain personality scales among engaged couples. *Psychol. Rep.* 26:465–66

350. Reiter, H. H. 1970. Some EPPS differences between smokers and nonsmokers. *Percept. Mot. Skills* 30:253–54

351. Ibid. Note on some personality differences between heavy and light drinkers, 762

352. Reiter, H. 1971. Relationships among four measures of anxiety. *Psychol. Rep.* 28:761–62

353. Rhoades, C. D., Edmonston, W. E. 1969. Personality correlates of hypnotizability: A study using the Harvard Group Scale of Hypnotic Susceptibility, the 16 PF, and the IPAT. *Am. J. Clin. Hypn.* 11: 228–33

354. Richardson, F. C. 1969. Effects of "feeling" and "behavior" instructions on responses to the EPPS: A replication. *J. Educ. Res.* 62:399

355. Rosenberg, S., Olshan, K. 1970. Evaluative and descriptive aspects in personality perception. *J. Pers. Soc. Psychol.* 16:619–26

356. Roubertoux, P. 1970. Personality variables and interest in art. *J. Pers. Soc. Psychol.* 16:665–68

357. Salas, R. G. 1968. Fakability of responses on the Eysenck Personality Inventory. *Aust. J. Psychol.* 20:55–57

358. Salas, R. G., Richardson, J. F. 1968. Some Australian data on Forms A and B of the EPI. *Aust. J. Psychol.* 20:11–13

359. Saltz, E. 1970. Manifest anxiety: Have we misread the data? *Psychol. Rev.* 77:568–73

360. Sarason, I. G. 1969. Birth order, test anxiety, and learning. *J. Pers.* 37:171–77

361. Schaefer, C. E. 1969. The self-concept of creative adolescents. *J. Psychol.* 72:233–42

362. Schludermann, S., Schludermann, E. 1970. Generalizability of California Psychological Inventory factors. *J. Psychol.* 74:43–50

363. Schmidt, H. O. 1969. Relationship between the IPAT Self-Analysis scale and the Marlowe-Crowne Personal Reaction Inventory. *Psychol. Rep.* 24:361–62

364. Schultz, D. P. 1969. The human subject in psychological research. *Psychol. Bull.* 72:214–28

365. Schwab, D. P. 1970. Counterbalancing and fakability of the Gordon Personal Inventory and Profile. *Psychol. Rep.* 26:671–75

366. Sciortino, R. 1969. Factorial study and analysis of factor variance of intellective self-ratings from a combined sample of male and female subjects. *J. Psychol.* 71:261–69

367. Ibid. Factorial study of general adaptability self-ratings by male and female subjects, 271–79

368. Ibid. Factorial study and analysis of factor variance of general adaptability self-ratings from a combined sample of male and female subjects. 72:169–77

369. Ibid. Factorial study of intellective self-ratings by male and female subjects. 73:9–17

370. Scott, W. A. 1968. Comparative validities of forced-choice and single-stimulus tests. *Psychol. Bull.* 70:231–44

371. Sechrest, L. 1968. Testing, measuring, and assessing people. In *Handbook of Personality Theory and Research*, ed. E. F. Borgatta, W. W. Lambert, 529–625. Chicago: Rand McNally. 1232 pp.

372. Sells, S. B., Demaree, R. G., Will, D. P. 1970. Dimensions of personality: I. Conjoint factor structure of Guilford and Cattell trait markers. *Multivar. Behav. Res.* 5:391–422

373. Ibid 1971. Dimensions of personality: II. Separate factor structures in Guilford and Cattell trait markers. 6:135–86

374. Shamberg, N., Baker, S., Burns, J. 1969. Reminiscence and pursuit rotor performance in introverts, extraverts, and neurotics. *Brit. J. Soc. Clin. Psychol.* 8:375–82

375. Shapiro, K. J., Alexander, I. E. 1969. Extraversion-introversion, affiliation, and anxiety. *J. Pers.* 37: 387–406

376. Shatin, L., Kotter, W., Longmore, G. 1968. Personality traits of music therapists. *Psychol. Rep.* 23:573–74

377. Sheridan, K., Shack, J. R. 1970. Personality correlates of the undergraduate volunteer subject. *J. Psychol.* 76:23–26

378. Sherrill, D. 1970. A situational restriction of the S-R Inventory of Anxiousness: Test anxiety. *Percept. Mot. Skills* 30:653–54

379. Sherrill, D., Salisbury, J. L. 1971. Manifest anxiety, extraversion, and neuroticism: A factor-analytic solution. *J. Couns. Psychol.* 18: 19–21

380. Siddle, D. A., Morrish, R. B., White, K. D., Mangan, G. L. 1969. Relation of visual sensitivity to extraversion. *J. Exp. Res. Pers.* 3:264–67

381. Siess, T. F., Jackson, D. N. 1970. Vocational interests and personality: An empirical integration. *J. Couns. Psychol.* 17:27–35

382. Signori, E. I., Schwartzentruber, A. M. 1969. Development of items for assessment of id, ego, and superego tendencies in a variety of moral situations. *Percept. Mot. Skills* 28:551–55

383. Silverstein, A. B., Fisher, G. 1968. Is item overlap responsible for a "built-in" factor structure? *Psychol. Rep.* 23:935–38

384. Simmons, D. D. 1970. Development of an objective measure of identity achievement status. *J. Proj. Tech. Pers. Assess.* 34:241–44

385. Simon, W. E. 1970. Self-concept and the validity of the Allport-Vernon-Lindzey Study of Values. *Percept. Mot. Skills* 31:263–66

386. Skinner, N. F., Howarth, E., Browne, J. A. 1970. Note on the role of neuroticism and extraversion in the "nice personality" stereotype. *Psychol. Rep.* 26:445–46

387. Smith, J. E. 1968. Personality structure in beginning nursing students: A factor analytic study. *Nursing Res.* 17:140–45

388. Smith, J. M., Schaefer, C. E. 1969. Development of a creativity scale for the Adjective Check List. *Psychol. Rep.* 25:87–92

389. Smith, R. E., Flenning, F. 1971. Need for approval and susceptibility to unintended social influence. *J. Consult. Clin. Psychol.* 36:383–85

390. Smith, S. L. 1968. Extraversion and sensory threshold. *Psychophysiology* 5:293–99

391. Spiegel, D. 1969. SPI and MMPI predictors of psychopathology. *J. Proj. Tech. Pers. Assess.* 33: 265–73

392. Spiegel, D. 1969. SPI discriminators among four psychological health-sickness levels. *J. Consult. Clin. Psychol.* 33:750–56

393. Spiegel, D., Brodkin, S. G., Keith-Spiegel, P. 1969. Unacceptable impulses, anxiety, and the appreciation of cartoons. *J. Proj. Tech. Pers. Assess.* 33:154–59

394. Spiegel, D., Hadley, P. A., Hadley, R. G. 1970. Personality test patterns of rehabilitation center alcoholics, psychiatric inpatients and normals. *J. Clin. Psychol.* 26: 366–71

395. Spiegel, D., Keith-Spiegel, P. 1969. Factor analysis of 78 variables from nine personality tests and scales. *J. Proj. Tech. Pers. Assess.* 33:160–67

396. Spiegel, D., Olivo, M. L., Keith-Spiegel, P. 1968. Tactual appeal and aversion: Validation of three predictors. *J. Proj. Tech. Pers. Assess.* 32:82–87

397. Stein, K. B. 1968. The TSC scales: The outcome of a cluster analysis of the 550 MMPI items. In *Advances in Psychological Assessment*, ed. P. McReynolds, 90–105. Palo Alto: Science and Behavior Books. 327 pp.

398. Stein, K. B. 1970. The TSC scales: Social undesirability or personal maladjustment? A reply to Edwards, Klockars, and Abbott. *Multivar. Behav. Res.* 5:157–58

399. Stewart, R. A. 1968. Academic performance and components of self-actualization. *Percept. Mot. Skills* 26:918

400. Stricker, L. J. 1969. "Testwiseness" on personality scales. *J. Appl. Psychol. Monogr. Suppl.* 53:1–18

401. Stricker, L. J., Messick, S., Jackson, D. N. 1969. Evaluating deception in psychological research. *Psychol. Bull.* 71:343–51

402. Sullivan, P. F., Roberts, L. K. 1969. Relationship of manifest anxiety to repression-sensitization on the MMPI. *J. Consult. Clin. Psychol.* 33:763–64

403. Swindell, D. H., Lieberman, L. R. 1968. Effect of sex on the correlation between the Dogmatism Scale and the Edwards Personal Preference Schedule. *Psychol. Rep.* 23: 893–94

404. Tanner, C. E., Pasewark, R. A., Fitzgerald, B. J. 1969. Use of the Edwards Personal Preference Schedule with paranoid schizophrenics. *Psychol. Rep.* 24:988

405. Tedeschi, J., Burrill, D., Gahagan, J. 1969. Social desirability, manifest anxiety, and social power. *J. Soc. Psychol.* 77:231–39
406. Templer, D. I. 1969. Death Anxiety Scale. *Proc. 77th Ann. Conv. APA* 4:737–38
407. Throop, W. F., MacDonald, A. P. 1971. Internal-external locus of control: A bibliography. *Psychol. Rep. Monogr. Suppl.* 28:175–90
408. Thumin, F. J. 1969. MMPI scores as related to age, education, and intelligence among male job applicants. *J. Appl. Psychol.* 53: 404–7
409. Tryon, R. C. 1966. Unrestricted cluster and factor analysis, with applications to the MMPI and Holzinger-Harmon problems. *Multivar. Behav. Res.* 1:229–44
410. Uecker, A. E., Kish, G. B., Ball, M. E. 1969. Differentiation of alcoholism from general psychopathology by means of two MMPI scales. *J. Clin. Psychol.* 25:287–89
411. Upper, D., Seeman, W. 1968. Brain damage, schizophrenia, and five MMPI items. *J. Clin. Psychol.* 24: 444
412. Vacchiano, R. B., Strauss, P. S., Hochman, L. 1969. The open and closed mind: A review of dogmatism. *Psychol. Bull.* 71:261–73
413. Van Atta, R. E. 1968. Relationship of personality characteristics to persistence in psychotherapy. *J. Consult. Clin. Psychol.* 32:731–33
414. Veldman, D. J., Parker, G. V. 1970. Adjective rating scales for self-description. *Multivar. Behav. Res.* 5:295–302
415. Vernon, P. E. 1969. *Personality Assessment: A Critical Survey.* New York: Barnes & Noble. 333 pp.
416. Very, P. S., Iacono, C. 1968. Phenylthiourea taste blindness and MMPI personality patterns in adult Caucasian females. *J. Clin. Psychol.* 24:187–88
417. Vesprani, G. J. 1969. Personality correlates of accurate empathy in a college companion program. *J. Consult. Clin. Psychol.* 33:722–27
418. Vincent, J. 1968. An exploratory factor analysis relating to the construct validity of self-concept labels. *Educ. Psychol. Meas.* 28: 915–21
419. Vingoe, F. J. 1968. Note on the validity of the California Psychological Inventory. *J. Consult. Clin. Psychol.* 32:725–27
420. Vondracek, F. W. 1969. Behavioral measurement of self-disclosure. *Psychol. Rep.* 25:914
421. Von Singer, R., Pederson, M. G. 1970. Behavioral correlates of the ACL Heterosexual scale. *Psychol. Rep.* 26:719–22
422. Walker, B. S., Little, D. F. 1969. Factor analysis of the Barrett-Lenard Relationship Inventory. *J. Couns. Psychol.* 16:516–21
423. Walker, D. N., Mosher, D. L. 1970. Altruism in college women. *Psychol. Rep.* 27:887–94
424. Wall, J. B. 1970. Relationship of locus of control to self-actualization. *Psychol. Rep.* 27:282
425. Walsh, J. A. 1968. Prediction of anchor effects on personality items from rating dispersions. *Educ. Psychol. Meas.* 28:317–25
426. Walsh, J. A., Penberthy, D. K., Earley, S. R. 1969. Relationship between estimated occurrence and social desirability scale value of objective personality items. *Psychol. Rep.* 24:621–22
427. Walsh, R. P. 1969. Test-taking anxiety and psychological needs. *Psychol. Rep.* 25:83–86
428. Waters, C. W., Waters, L. K. 1969. Relationships between a measure of "Sensation Seeking" and Personal Preference Schedule Need Scales. *Educ. Psychol. Meas.* 29: 983–85
429. Waters, L. K. 1968. Stability of Edwards Personal Preference Schedule Need Scale scores and profiles over a seven week interval. *Educ. Psychol. Meas.* 28:615–18
430. Watson, C. G. 1971. An MMPI scale to separate brain-damaged from schizophrenic men. *J. Consult. Clin. Psychol.* 36:121–25
431. Weigel, R. G., Frazier, J. E. 1968. The effects of "feeling" and "behavior" instructions on responses to the Edwards Personal Preference Schedule. *J. Educ. Meas.* 5: 337–38
432. Weiser, J. C. 1970. Personality variables associated with creativity in prospective female teachers. *J. Stud. Personnel Assoc. Teacher Educ.* 8:77–84
433. Weissman, H. N. 1970. Disposition toward intellectuality: Its composition and its assessment. *J. Gen. Psychol.* 82:99–107

434. Wherry, R. J., Waters, L. K. 1968. Motivational constructs: A factorial analysis of feelings. *Educ. Psychol. Meas.* 28:1035–46

435. White, K. D., Mangan, G. L., Morrish, R. B., Siddle, D. A. 1969. The relation of visual after-images to extraversion and neuroticism. *J. Exp. Res. Pers.* 3:268–74

436. Wiggins, J. S., Wiggins, N., Conger, J. C. 1968. Correlates of heterosexual somatic preference. *J. Pers. Soc. Psychol.* 10:82–90

437. Williams, C. 1969. Meaningfulness of the Eysenck Personality Inventory Lie scale. *Aust. Psychol.* 4:54–58

438. Williams, C. D., Bruel, I. 1968. Evidence for the validity of the construct of intraception. *J. Clin. Psychol.* 24:188–89

439. Wine, J. 1971. Test anxiety and direction of attention. *Psychol. Bull.* 76:92–104

440. Worthy, M. 1969. Note on scoring midpoint responses in extreme response-style scores. *Psychol. Rep.* 24:189–90

441. Ziller, R. C., Hagey, J., Smith, M. D., Long, B. H. 1969. Self-esteem: A self-social construct. *J. Consult. Clin. Psychol.* 33:84–95

442. Zuckerman, M. 1971. Dimensions of sensation seeking. *J. Consult. Clin. Psychol.* 36:45–52

443. Zuckerman, M., Neary, R. S., Brustman, B. A. 1970. Sensation-Seeking Scale correlates in experience (smoking, drugs, alcohol, "hallucinations," and sex) and preference for complexity (designs). *Proc. 78th Ann. Conv. APA* 5:317–18

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PHYSIOLOGICAL PSYCHOLOGY: SLEEP

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INTRODUCTION

Although the experimental analysis of sleep is a relatively new endeavor, questions concerning the nature of sleep, its physiological basis, and its adaptive significance now challenge investigators from nearly every discipline of the behavioral and biological sciences. During the past 20 years, the rate of scientific publication on sleep in man and animals, on its neural and biochemical substrates, on alterations of sleep by aging, drugs, and illness, on the relation of sleep states to mental activity, and on the behavioral and physiological effects of loss of sleep has risen from a few articles per year to more than 60 articles a month. The remarkable growth of this enterprise was stimulated on the one hand by significant advances in physiological and behavioral technology which began in the 1950s, and on the other by several landmark discoveries which occurred in that decade. Among these was the demonstration by Aserinsky & Kleitman (7, 9) and by Dement & Kleitman (40) that the periodic occurrence of vigorous conjugate ocular activity in the presence of electroencephalographic (EEG) desynchrony is associated in humans with vivid, visual, hallucinatory dreams. This, and the immediate confirmation by Dement (35) of similar periodic bioelectric patterns in the cat encouraged the view that sleep was not simply a periodic state of rest accompanied by reduced contact with the external environment.

Prior to these discoveries, slow cortical activity had been considered the principal EEG index of sleep (e.g. 74, 173). With the work of Kleitman's group and the extraordinary series of studies by Jouvet and his colleagues (89), it became clear that EEG slow waves were not invariable symptoms of sleep, for in humans the low-voltage, variable frequency EEG of the new state resembled that found in relaxed waking or drowsiness, and in cats the pattern was indistinguishable from the fast, desynchronized activity found during peak alertness. Furthermore, these early experiments by Jouvet and co-workers indicated that in cats the slow-wave manifestations of orthodox sleep depended on the integrity of the telencephalon, whereas the new stage, accompanied by rapid EEG patterns, was triggered by structures of the rhombencephalon. Thus it rapidly became clear that sleep was composed of at least two qualitatively different states controlled by different neural systems.

Jouvet suggested that the two states be labeled telencephalic and rhombencephalic sleep. A great many other names have been recommended for the latter stage of sleep: REM (for the rapid eye movements), paradoxical sleep (for reasons that will become evident), dreaming sleep, the D state, emergent stage 1, fast sleep, active sleep, light sleep, and deep sleep. Following the terminology recommended in the recent sleep-scoring manual by Rechtschaffen & Kales (169), we will refer to this phase as REM sleep or stage REM. Orthodox slow-wave sleep has also been given many labels. When referring to that stage as a composite single category, we will use the term non-REM (NREM) sleep.

The finding that sleep is characterized by periodic alternation of at least two entirely different physiological states had profound significance for theories concerning the physiological basis of sleep. Since the speculative hypotheses of the ancient Greek philosophers and physicians (see 105, 135 for reviews), theories about the biological mechanisms of sleep have been either neural or humoral. In the neural hypotheses, sleep was viewed either as a passive phenomenon, the absence of waking, or as an active event resulting from inhibition of the structures responsible for waking. The passive view, which has become known as the theory of deafferentation (135), served for years as a powerful guide to investigation of the neural mechanisms of sleep. It will be noted that for advocates of that view the principal problem is to identify the neural structures and functions which are responsible for waking rather than sleep and to explicate how and why their activity is periodically depressed to a level such that waking cannot be sustained. Proponents of the alternative view, that sleep is an active state resulting from inhibition of the waking system, were encouraged by the elegant work of von Economo (45). His anatomico-clinical investigations of encephalitis lethargica convinced him that there existed a sleep-producing center extending caudally from the region of the third ventricle to the aqueduct which could exert an inhibitory influence on the cerebral cortex. Since those studies and the classic electrical brain stimulation experiments of W. R. Hess (73), a considerable body of evidence has developed that there exists in the brain of mammals a widely dispersed system of structures which can actively induce and sustain the electrical and behavioral phenomena of sleep (see 177).

Probably all contemporary investigators agree that there are mechanisms in the brain capable of active induction of certain physiological and behavioral symptoms of sleep. There is disagreement, however, as to whether these mechanisms are either necessary or sufficient explanations of the states of sleep and whether the symptoms they control are fundamental or superficial manifestations of the sleeping process. Many scientists in the field, including the present reviewers, are convinced that both passive and active neural processes are involved in sleep, but that, at least in their simpler forms, the two concepts taken together may not be sufficient to explain the astounding complexity of sleep processes. As was pointed out earlier, prior to the 1950s the two alternative hypotheses were competing explanations of a single phenomenon, the periodic occurrence of behavioral quiescence accompanied by EEG slow activity. As data develop on the phenomenology of sleep states, it becomes increasingly clear that sleep is not simply a resting state, waxing and waning near the lower pole of a continuum of vigilance. Instead, sleep appears to be an extremely complex, constantly changing, but cyclic succession of psychophysiological patterns, qualitatively rather than quantitatively different from those of waking. As will be seen in this review, the symptoms of both REM and NREM sleep in mammals represent alterations in sensory, motor, autonomic, and central nervous system functions which must require reorganization of the entire brain.

Although the techniques and concepts of neurophysiology continue to provide most powerful tools for the analysis and explanation of sleep mechanisms, it seems certain that in the next decade humoral theories will have their day. The relatively long time course of the states of sleep, the regular ultradian cycle which organizes their occurrence, and the persistence of their response to pharmacological, neurological, or psychological perturbation all recommend neurochemistry as the basic science of sleep. Nevertheless, the examination of biochemical substrates of sleep states in man and animals has just begun. Studies to be reviewed here which have implications for the chemistries of sleep are correlative rather than causative in their conception.

Despite the extraordinary research effort expended on the states of sleep over the past 20 years, we have very little evidence concerning their adaptive significance as biological processes. Investigators of the decade of the 1950s were reasonably confident that the application of traditional physiological principles would provide clues to the biological role of sleep. Thus, detailed analysis of structures and their relations often generates viable concepts about the biological functions of a phenomenon, especially when the results of such analysis are compared with the effects of deprivation of the organ or system (39). The reader will find that in the case of sleep neither analysis of its physiological substrates nor specific deprivation of its stages has provided a basis either for rejection or enthusiastic acceptance of any of the theories of function in the current literature. On the other hand, something has been learned about the physiological mechanisms for the induction, maintenance, and termination of the states of sleep.

There are several recent books which contain comprehensive analyses of sleep phenomena as well as reviews of early and contemporary research and discussions of neural and humoral mechanisms of sleep (see 2, 55, 64, 96, 102, 105, 107, 147, 202, 214). The following review articles are also representative (36, 39, 90, 91, 138, 209).

After summarizing our knowledge on peripheral and central phenomena of the states of sleep, this review examines evidence for their neural and biochemical substrates and discusses the current status of passive and active theories of sleep. There follows a very brief discussion of several contemporary hypotheses about the adaptive significance of REM and NREM sleep. The review treats inadequately several important areas of sleep research, including drugs and sleep, disorders of sleep, the psychology of sleep and dreams, the behavioral and physiological effects of total sleep deprivation, and the significance of altered sleep patterns for medical illness and psychopathology. The reader interested in these areas will want to consult the following books and reviews On drugs and sleep, see Kales (96) and Oswald (148); for disorders of sleep, see Oswald (149), Gastaut et al (55), Kales & Tan (97); for more extended analysis of research on sleep in infants and on the effects of aging, see Lenard (112), Dreyfus-Brisac (44), Feinberg (50); books by Foulkes (54), Jones (87), Hall (60), Kramer (110), Murray (141), and a review by Fisher (52) examine the psychology of sleep and dreams; the behavioral and physiological alterations caused by selective and total sleep deprivation are discussed by Johnson (85), Webb (203, 204), and Luby & Gottlieb (119); for sleep and psychopathology, see Snyder (190), Hartmann (66), and Zarcone & Dement (220).

In 1968, the Brain Information Service of UCLA began monthly publication of the *Sleep Bulletin*, which contains up-to-date citations of much of the world literature on sleep physiology and psychophysiology. Recently the citations in the *Bulletin* have been supplemented by analytical reviews of research reports in the current scientific literature. About 100 sleep reviews per year are contributed by members of the Association for the Psychophysiological Study of Sleep (APSS), the international organization of sleep researchers which was established in 1960.

PHENOMENA OF SLEEP

THE HUMAN ELECTROENCEPHALOGRAM

Systematic analysis of the physiology of sleep began with the discovery of the EEG by Berger in 1929 (15), but the first standards for classification of the stages of sleep and waking were set forth by Loomis and his collaborators (31, 118). They found that sleep in humans is associated with a series of EEG states which they labeled A through E for their order of occurrence after sleep onset and for their ordinal relation to threshold for behavioral arousal. Stage A, characterized by intermittent loss of the alpha rhythm of quiet waking (8–12 Hz), and stages D and E with their slow (0.6–1.5 Hz) high-voltage delta waves, were described as the "lightest" and "deepest" states of sleep, respectively. The Loomis et al classification was used by most investigators until Aserinsky & Kleitman (7, 9) discovered the periodic state of REM sleep. In 1957, Dement & Kleitman showed that arousal thresholds in this phase were higher than for the period shortly after sleep onset. Further, they found that when awakened from stage REM, their subjects reported vivid dreams, such reports being rare in other sleep states. These investigators then proposed a classification in which there were five stages of sleep. The Loomis et al stages A through E were collapsed to stages 1 (intermittent alpha activity) through 4 (high-voltage delta), during which rapid eye movements were absent. They are referred to collectively as non-REM (NREM) sleep. To this classification was added the fifth stage REM. The Dement-Kleitman system for classifying the stages of sleep in humans is now in wide use and is the basis for the Rechtschaffen-Kales manual on sleep terminology, scoring, and techniques published in 1968 (169).

During a normal night of sleep in adult humans, the first REM episode occurs from 40 to 80 min after sleep onset, and the subsequent REM-to-REM cycles recur every 90–100 min, with decreasing amounts of stage 4 and increasing REM-period durations. The first episode of stage REM may persist no more than 2 to 5 min and is sometimes skipped altogether, whereas the late-occurring epochs may last for as long as 30 to 60 min. Typically, REM and slow-wave (SW) sleep (stages 3 and 4 summed) each occupy about 20% of the total night of sleep. In normal adult mammals, NREM sleep always precedes REM sleep. Since the work of Dement & Kleitman, these general characteristics of the sleep cycle have been confirmed by a host of investigators (e.g. 11, 94, 213).

DEPTH OF SLEEP AND AROUSAL THRESHOLDS

An important reason for using the EEG as a fundamental measure of sleep in mammals is that it correlates reasonably well with behavioral criteria of waking and sleep. It is a particularly sensitive indicator of sleep onset, and as Loomis et al (118) first showed, thresholds for behavioral arousal and the likelihood of organized behavioral patterns are generally decreasing functions of the amplitude and period of background EEG rhythms. This is what led to the notion that the sleep stages from 1 through 4 are on a continuum of "depth." However, as the properties of stage REM were revealed, the concept "depth of sleep" became difficult to sustain. In this stage of emergent stage 1, thresholds for awakening are higher than for stage 1 at the onset of sleep (40, 211) and there is extreme loss of postural tone. Yet there are signs of intense cortical and autonomic activation. More than for other stages of sleep, behavioral response thresholds in stage REM appear to be a function of the meaning of stimuli presented to the subject (212). Dement & Kleitman classified stage REM as an intermediate stage somewhere between waking and stage 2, but because it proved difficult in cats to provoke behavioral arousal from stage REM by direct electrical stimulation of the brain stem reticular formation (e.g. 14), and because blood pressure and heart rate fell in the cat during this state, animal researchers labeled stage REM "deep" sleep. This led to unfortunate differences in terminology between investigators of animals and humans.

In general, with neutral stimuli such as clicks, flashes, peripheral electric shocks and the like, the intensity required to arouse the sleeping organism is higher than that required for reliable responding during waking. This well-known fact could be taken as evidence that in sleep the thresholds of sensory transducers are raised or conduction in afferent pathways is diminished. Many investigators, recording sensory evoked responses with gross and microelectrodes, have investigated the status of the afferent pathways during sleep (see 107, 108 for reviews). These studies, along with evidence that conditioned motor responses can be elicited during sleep (24, 212) and the common observation that meaningful or novel stimuli can arose the organism from any stage of sleep, indicate that the information-handling capacity of the sensory systems is probably not impaired during sleep. Thus the failure to arouse the sleeping organism by sensory stimuli whose intensity is above waking sensation thresholds requires some other interpretation. Koella (107) pointed out that the "arousal value" of stimuli depends on their quality as well as their strength. For example, weak stimuli that are novel or unexpected (e.g. the offset of a continuous sound) or have biological adaptive significance (e.g. the smell of fresh meat to the sleeping cat) may cause immediate awakening. Koella suggested, therefore, that during sleep, sensory analyzer mechanisms in the brain remain operative so that incoming signals can be categorized as "important" or "unimportant." With the former decision, messages are dispatched to the brain stem activating mechanisms to produce arousal; if the latter, sleep is allowed to continue. Studies in humans by Oswald et al (151), Zung & Wilson (221), and Williams et al (212), showing that discriminative responses can occur during sleep, support this notion. Nevertheless, an elegant series of studies by Pompeiano's group (159) has elaborated central mechanisms in the cat which by active downstream inhibition do alter sensory conduction during the REM stage.

One important problem with the concept of depth of sleep is that there is apparently no general index for such a dimension. Williams et al (211) found that in humans responsiveness varies not only according to stage of sleep, but with time of night, the nature of the arousing stimulus, and the index of responding. For example, vasomotor responsiveness to neutral acoustic stimuli showed a different pattern across stages of sleep and time of night than behavioral or EEG responsiveness. These diverse facts are probably responsible for the conflicting findings on arousal thresholds reported by Pisano et al (155), Rechtschaffen et al (168), and Williams et al (211). It appears that the notion of depth of sleep as an explanatory concept should be abandoned.

PSYCHOPHYSIOLOGY

In general, the physiological characteristics of sleep are similar across mammalian forms (191). Long periods of relative immobility are accompanied by a number of common physiological changes, and nearly all mammals show periodic shifts from NREM to REM sleep, accompanied by a change from slow EEG patterns to fast EEG patterns, and by a shift from relative ocular quiescence to vigorous ocular mobility.

Autonomic system.—Since the discovery of REM sleep in man, nearly every physiological variable which can be recorded from the surface of the body has been measured during sleep. Most of these measures show distinct and characteristic changes during REM sleep, compared to their levels or patterns during the NREM stages. In humans, average blood pressure, heart rate, and respiration rate decline after the onset of NREM sleep, reaching rather low and stable levels about 2 hr after sleep onset (184, 192). Transient peripheral vasodilation (a sign of relaxation) occurs at sleep onset, then also tends to stabilize at slightly lower levels during the NREM states (210, 211). With the onset of REM, average levels of these cardiorespiratory measures change toward activation. Much more diagnostic of the REM phase, however, is the marked increase in their moment-to-moment variability (103, 192). These fluctuations are systematically associated with the bursts of rapid eye movements (8). In cats, heart rate and blood pressure show a small decline with NREM sleep and a precipitous drop, accompanied by increased irregularity, during stage REM (26).

Blood flow in the cerebral cortex of cats shows no systematic change from waking during NREM sleep, but increases dramatically during stage REM, apparently because of autonomically modulated vasodilation (101). In cats and rabbits, this latter change is accompanied by increased brain temperature (100, 167). A preliminary report by Reite & Pegram (171) indicates that in primates, cerebral blood flow may also show an increase during the REM state, but accompanied by *decreased* brain temperature.

As is well known, the urinary and rectal sphincters are contracted during sleep, a sign of high tonus in at least one part of the sympathetic nervous system. Conversely, the pupillary constriction found during sleep is a function of both decreased sympathetic tone and increased parasympathetic output (183). The pupil tends to remain in extreme tonic miosis during stage REM (89) but may show abrupt dilation during intense bursts of eye movements; Berlucchi et al (19) found that these phasic changes were not eliminated by preganglionic cervical sympathectomy and concluded that they were probably due to phasic inhibition of parasympathetic processes.

In 1944, Ohlmeyer et al (145) reported that penile erection averaging about 25 min in duration occurred about every 85 min during sleep. Several recent studies confirmed this observation and showed that the erection cycle is concordant with the REM-sleep cycle (e.g. 53, 98). Because of the temporal distribution of stage REM through the night, with longer periods in the early morning, it is common for morning awakening to terminate a REM episode. It now appears that the well-known erection with morning awakening depends on the neural properties of stage REM rather than on bladder distension, as was previously supposed.

In humans, basal skin resistance increases after the onset of NREM sleep and was first reported to show a further increase during stage REM (68). However, a recent study by Tart (196) failed to confirm the latter observation. Surprisingly, spontaneous fluctuations in skin resistance and skin potential (nonspecific GSRs and SPRs) are very frequent during NREM sleep and virtually absent during stage REM (6, 86). Thus autonomic measures such as fluctuations in skin conductance and cardiac rate, which during waking tend to covary with arousal, become dissociated during sleep.

Skeletal system.—Although general muscular relaxation in humans usually precedes and accompanies NREM sleep, electromyographic recordings show that tonic muscle potentials are not entirely abolished during this phase (16). Further, despite early evidence to the contrary (e.g. 111), spinal reflexes can be demonstrated during NREM sleep (79), Similarly, the presence of the Babinski reflex in humans (see 105, p. 16), the curled-up sleeping positions in cat and dog, and the standing positions of birds and horses are manifestations during the NREM states of tonic activity in the skeletal-motor system.

During REM sleep, in the presence of signs of intense activation in structures of the central and autonomic nervous systems, the body becomes profoundly relaxed, loss of muscle tone in the neck of the cat and the jaw region of man being complete (16, 88). Such findings account for the designation, paradoxical sleep. It is now understood that this is a true paralysis induced by tonic inhibitory influences on motor output. Several studies by Pompeiano and co-workers (101, 161) demonstrated active tonic suppression of motor reflexes in cats, while Hodes & Dement (79) found suppression of the H-reflex in humans. The state of tonic inhibition during the REM state is probably identical with that found during the cataplectic attack (41). Superimposed, however, on this background of inhibition are twitches and tremors of the face and the extremities which are closely associated with the bursts of rapid eye movements and with the phasic autonomic irregularities described above (11).

CENTRAL PROCESSES

When electrical potentials are recorded from depth electrodes, the onset of NREM sleep in cats is marked by the emergence of slow waves in the deeper layers of the frontal cortex (usually layer 4). As sleep develops this slow activity spreads, first to more superficial layers of the frontal cortex, then to the remainder of the cortical mantle, then to diencephalon and the mesencephalic reticular formation (109). According to Kogan (109), undercutting the cerebral cortex, thus destroying ascending pathways, does not halt the initial propagation of slow waves across the cortex, whereas cross-cutting the cortex, destroying intracortical pathways, does. The fact that the electrical signs of sleep emerge first in the cortex, whence they are apparently propagated to deeper structures, suggests that the intact cortex may be necessary for the occurrence of NREM sleep. Indeed, Jouvet and his colleagues (89) found that during the survival period of neodecorticate cats (up to 3 months) there was a permanent absence of spindles and slow waves in subcortical structures. On the other hand, all of the symptoms of stage REM continued to appear with astonishing regularity. Taken together, the studies of Jouvet and those of Kogan suggest that NREM sleep may be actively induced by structures in the cerebral cortex. As will be seen, although there are mechanisms available in the brain for such corticifugal control, the notion has not been thoroughly investigated. The more popular view is that subcortical structures are responsible for triggering the synchronization phenomena found at the cortex.

Recording the activity of single neurons in the brain with microelectrodes had considerable import for theories about central mechanisms of sleep because no sleeping neurons were found. Creutzfeldt & Jung (30), studying single units in the motor cortex of the *encephale isolé* cat, found that concomitant with the onset of NREM sleep the regular and nearly continuous spike activity shifted to a periodic burst pattern with periods of silence between the bursts. This grouping pattern was most pronounced in fast or medium frequency neurons (average firing rate, 5 or more per second), and identical burst patterns were found in sets of neighboring neurons. The average discharge frequency for fast or intermediate sets decreased slightly with sleep onset, and increased again with arousal, whereas the mean for slow units increased during sleep. Similar results were reported by Li (114) in somatosensory cortex, by Saito et al (181) in suprasylvian and sensory cortex, and by Murata & Kameda (140) for auditory, visual, and motor cortex, the latter in unanesthetized, freely moving cats. Evarts and colleagues (e.g. 47, 48), studying chronically prepared cats and monkeys and recording from cortex and brain stem, also found that the average discharge frequency occurring with the transition from waking to sleep depends on the initial discharge rate. Further, they confirmed the finding that units which discharged at a fairly regular rate during restful waking fired in bursts with intervening silent intervals during sleep.

During REM sleep in cats, the central activity recorded from gross electrodes suggests intense arousal. The same fast, desynchronized activity found at the cortex also occurs in diencephalic and mesencephalic reticular formation, whereas the hippocampus emits a very regular slow theta rhythm (about 6 Hz) identical to that seen with arousal (90). Out of this background of tonic activity there emerges an intermittent burst pattern of large, fast spikes which originate in the pons from which they are apparently propagated to the lateral geniculate nucleus, the occipital cortex, and other brain areas (90). These ponto-geniculo-occipital (PGO) spikes are usually coincident with the other phasic phenomena, the eye movements, muscle twitches, and autonomic irregularities of stage REM. They are probably identical to the spikes which follow eye movements in the waking state. A series of studies by Dement and his colleagues (summarized in 39) indicate that these phasic electrical events may have fundamental significance for our understanding of the functional properties of the REM state.

Single unit recordings with depth microelectrodes in the cat confirm the view that during stage REM the brain is in a state of intense excitement. Groups of neurons throughout the brain now show integrated burst patterns with very high discharge rates, the bursts being separated by long pauses (see, 4, 49, 157). Arduini et al (4), Evarts (48), and Marchiafava & Pompeiano (127) found a dramatic acceleration of pyramidal tract discharges during stage REM in the cat which are associated with and probably account for the phasic muscular twitches. These episodic, high-frequency burst patterns resemble phenomena found in convulsive states, and there are other features of REM which indicate that the cortex is in a state of heightened excitability. For example, during the REM state, peripheral motor responses increase with direct stimulation of the cortex (80), as do the electrical discharges elicited by local applications of strychnine to the cortex (146). Further, several investigators have reported enhanced cortical responses during stage REM to stimulation of specific afferent pathways or cortical sites (90).

It will be recalled that along with the peripheral and central phasic phenomena, a most salient tonic feature of REM sleep is the suppression of both electromyogram (EMG) potentials and muscle reflexes. How can the organism remain relatively quiet in the presence of intense activation throughout the brain? An answer comes from the work of Pompeiano and his collaborators (summarized in 158). They found that during stage REM, both monosynaptic and polysynaptic reflexes were greatly reduced or abolished and that complete transection of the spinal cord eliminated these inhibitory effects. They showed further that both the marked decrease in postural tone and the dramatic reduction of spinal reflexes depend on active inhibitory processes originating in the brain stem.

The review given above of our knowledge of the phenomena of sleep states is cursory. Yet perhaps it is sufficient to indicate that the NREM and REM states are characterized by changes of activity in all physiological functions so far studied—that the states of sleep represent unique patterns of activity in many functional units rather than simple reduction of activity in all systems.

SLEEP PHYLOGENY AND ONTOGENY

Periodic episodes of behavioral quiescence probably occur in all animals, but the EEG manifestations of behavioral sleep found in mammals, birds, and some reptiles do not appear in all vertebrates. Hobson (78) and Lucas et al (120) failed to find EEG sleep in the frog or salamander, and Peyrethon (153) reported that in fish (*teleosts*) cerebral activity showed no variation between states of activity and immobility.

Stage REM is found in nearly all mammals, including chimpanzee, monkey, porpoise, cat, dog, rat, rabbit, mouse, pig, guinea pig, sheep, goat, and bat (see 21, 129, 191). However, despite its regular occurrence in the sleep of a primitive mammal, the opossum (189), its presence in more ancient forms remains uncertain. Allison & Goff (3) found no signs of stage REM in one of the oldest living mammals, the spiny anteater. Newly hatched chickens when behaviorally quiescent have a low-voltage EEG accompanied by ocular activity (58), whereas adult birds show periods of sleep which, though equivalent to stage REM, last only a few seconds (104). Transient episodes of nonconjugate ocular activity on a *slow* EEG background were observed in chameleons (197). Recently, Peyrethon (153) reported EEG signs of REM sleep in the *caiman* (crocodile) but not in iguana or python. He concluded that during the course of evolution, REM sleep first appears in the crocodile. Note, however, that Jouvet and his colleagues (90) found no stage REM in another reptile, the turtle, and Hobson (78) saw no REM (or NREM) sleep in the frog, an amphibian.

There is some but not very systematic evidence that animals with many natural predators (e.g. herbivores) have less REM than the predatory carnivores. Hartmann (67) suggests that animals which are preyed upon may not be able to afford the complete loss of muscle tone and raised arousal threshold which characterize this state. Berger (17) brought some order to comparative data by showing that the percentage of REM sleep is apparently related to the amount of binocularly coordinated eye movement possessed by each species. On the basis of this and other data, he suggests that REM sleep may be functionally involved in the establishment and maintenance of the coordinated eye movements which are necessary for depth perception.

The rate of occurrence of the REM state, defined by the period of the REM-to-REM cycle, also varies between species. The longest REM-to-REM cycles have been found in the elephant (over 100 min) and man (90–100 min) and the shortest (about 7 min) in the mouse. Apparently the frequency of occurrence of REM periods is a function of the basal metabolic rates of the species. Weiss & Roldan (207) compared the length of the REM cycle in three of the rodents—rabbit, rat, and mouse—and found that the frequency of REM episodes increased as body weight (and probably metabolic rate) decreased (see 18).

Studies of ontogeny do support the view that stage REM is a primitive biological phenomenon. The very young of a species usually spend far more time in stage REM than the adult (see 191). For example, at birth the kitten shows only two states of activity: waking and stage REM. Further, unlike the adult cat, the kitten passes directly from waking to stage REM without transition through NREM states. Shortly after birth the NREM EEG emerges, and the two states reach adult levels at about 8 weeks (90). The proportion of stage REM found at birth seems to be an inverse function of the maturity of the nervous system at term. For example, sleep patterns in the neonate guinea pig, which is born with a fully developed brain, are nearly identical to those of the adult animal (90).

Newborn humans spend about 50% of their daily sleep time (around 18 hr) in stage REM, and premature infants (e.g. 43) may spend as much as 75% of their sleep time in the REM state. It is not certain, however, when the REM state first appears in the developing fetus. In previable prematures from 24–27 weeks gestational age, Dreyfus-Brisac (44) found only atypical EEG patterns which could not be classified as REM, NREM, or waking. Using EEG criteria, REM and NREM sleep were distinguished at about 29 weeks, but the full constellation of REM symptoms rarely appeared prior to the 34th week (see 112 for a review). These data on neonates and prematures indicate that stage REM is a very primitive stage, ontogenetically, and that it may develop prior to NREM sleep.

Kleitman (105, 106) has suggested that the periodic alterations seen in activity of species at or below the reptilian level which do not manifest the usual EEG signs of sleep and waking represent a basic "rest-activity cycle" which involves a more primitive level of neural organization than that mediating the sleep-waking cycle. Sterman & Clemente (194) argue that such a rest-activity cycle is probably mediated by brain stem structures and is most clearly represented in mammals by the REM-NREM cycle. Sterman & Hoppenbrouwers (195) in fact present evidence that adult EEG sleep-waking rhythm is absent in the human fetus and only poorly organized in the human newborn. These authors concluded that the dominant rhythm found early in life is the more primitive rest-activity cycle.

NEURAL MECHANISMS OF WAKING AND SLEEP

As was mentioned earlier, one of the classic issues in theories and research on sleep mechanisms has been the relative role of passive versus active neural processes for the induction and maintenance of sleep.

Since mechanisms essential for maintenance of wakefulness have a critical role in theories which view sleep as a passive defacilitation process, they will be reviewed first. The status of the passive position will then be examined in light of evidence suggesting that active neural processes contribute to sleep onset. Finally, studies relating to the mechanisms, organization, and sequencing of NREM and REM patterns of sleep will be examined.

WAKEFULNESS

Although normal waking functions depend upon the integrity of the entire brain, certain subcortical areas have a critical role in sustaining the behavioral and EEG manifestations of waking. In 1929, von Economo noted that patients suffering from encephalitis lethargica had lesions of the posterior hypothalamus, tuberal region, and adjacent portions of the striatum. Ranson & Ingram (165) found similar profound drowsiness in cats with lesions located between the mammillary bodies and the rostral fibers of the third nerve. Later, Ranson (164) showed that lesions of the lateral hypothalamus extending to the caudal border of the mammillary bodies were most effective in producing lethargy in monkeys. These results were subsequently confirmed in the rat (144) and cat (166). Ranson interpreted his results as indicating that lesions of a "waking center" eliminated downstream hypothalamic drive influences (174). Nauta (143), however, while agreeing that maximal impairment of waking occurred with lesions in and around the mammillary bodies, concluded that the waking center was an ascending system whose origins lay caudal to that region in the midbrain tegmentum. Thus, lesions which interrupted such fiber systems as the median forebrain bundle interfered with the relay of impulses from more caudal regions of the brain stem to the lateral hypothalamus, anterior nucleus of the thalamus, and septal region. This notion of an ascending waking system was of course greatly strengthened by the earlier findings of Bremer (22), who described animals with an intracollicular midbrain transection (*cerveau isolé* preparation) as displaying permanent signs of sleep.

In 1949, Moruzzi & Magoun provided the first clear evidence that the brain stem recticular formation, an ascending fiber system independent of the classical sensory pathways, may function as the primary center for wakefulness. They found that high-frequency stimulation throughout this structure reproduced all of the electrographic signs of arousal and also blocked the synchronous recruiting responses elicited by stimulation of midline thalamic areas. Subsequently, lesions of the midbrain reticular nuclei in either chronic (116) or acute (115) preparations were found to produce a comatose behavioral state similar to that seen in the *cerveau isolé* animal.

Ascending impulses from the tonically active midbrain reticular system, modulated by a complex array of sensory inputs and cortico-reticulo-cortical loops, were thought to provide the essential facilitative effects on cortex and other brain structures necessary for the waking state. Even very recently there are reports that repeated midbrain reticular stimulation can maintain wakefulness for periods up to two weeks (82).

A critical issue for those advocating the rostral reticular formation as the wakefulness center was the role of sensory input in maintaining reticular tonus.

In a low *cerveau isolé* preparation, where transection is below the collicular level and visual inputs are still intact, the EEG is characterized by alternating periods of cortical spindles and desynchronized activity but with no sign of ocular waking, i.e. dilated pupils (179). When visual input is eliminated by occluding the retinal blood supply, the EEG in this preparation reverts to the spindle and slow-wave pattern seen in the high or precollicular *cerveau isolé*. The second classical preparation of Bremer (22), the *encephale isolé*, where the brain stem is isolated from the cervical spinal cord, apparently displays normal sleep-waking EEG rhythms, but with prolonged epochs of cortical desynchrony following sensory stimulation. However, when care is taken to remove trigeminal and other sensory inputs, the animal displays chronic cortical and ocular signs of sleep (see 198). From these latter studies it appeared possible that the principal function of the midbrain reticular formation was merely to mediate the magnitude of sensory barrages, particularly nociceptive input from the trigeminal. However, Batini et al (13) discovered that cats with a transection just rostral to the trigeminal nerve (the midpontine pretrigeminal preparation) reverted to alternating periods of cortical synchrony and desynchrony as well as prolonged periods of cortical desynchrony in response to visual stimulation. Neither suppression of the retinal dark discharge (5) nor deafferentation of visual and olfactory inputs (12) significantly disturbed the alternations between cortical synchrony and desynchrony. It will be recalled that the high *cerveau isolé* preparation of Bremer shows only chronic sleep patterns. These results not only ruled out sensory input as essential for producing cortical desynchrony, but also suggested that, in addition to the midbrain reticular formation, there existed a second activating system located in the rostral pons. Moruzzi (136) tentatively identified this active structure as the nucleus reticularis pontis oralis (NRPO).

There is other evidence that challenges the hypothesis that the reticular formation of the mesencephalon is uniquely responsible for wakefulness. For example, Adamętz (1) found that, given sufficient time for recovery, two-stage lesions large enough to produce coma had no effect on the sleep-waking cycle. Such recovery of wakefulness after lesions of the midbrain reticular core strongly suggests that there are other brain regions which can provide the tonic barrage of facilitatory impulses thought necessary to sustain wakefulness. Furthermore, high-frequency stimulation of portions of the thalamus, amygdala, and cerebral cortex also elicits electrographic signs of arousal. Although this may occur via centrifugal pathways to the midbrain (201), Routtenberg (180) suggested that such centrifugal arousal effects may be mediated by the reticular system of the rostral pons, i.e. the NRPO.

Further complicating the case for the midbrain reticular system is the fact that dissociation of cortical and behavioral arousal effects can occur with lesions of the posterior hypothalamus (51). Such lesions produce a behaviorally comatose animal which can still display cortical desynchronization to peripheral stimuli. Nauta (144) has described extensive reciprocal connections between the posterior hypothalamus and the midbrain reticular formation. Gellhorn (56) presents a compelling argument for parallelism between the cortical activation effects ascending from the midbrain and the downstream discharge from the posterior hypothalamus which results in increased muscle tonus and sympathetic activation. Routtenberg (180) also discusses possible mechanisms governing the interaction between hypothalamic and midbrain waking systems.

The anatomical pathways mediating the cortical activating effects of the midbrain reticular formation appear to course ventrally in the diencephalon through the subthalamus and hypothalamus, largely bypassing the thalamic reticular nucleus (186). Fibers within this ventral bundle may be differentiated at a neuropharmacological level. There is extensive evidence of an ascending noradrenergic pathway, coursing ventrally through the hypothalamus from the rostral brain stem, which is involved in arousal and onset or maintenance of waking (see 27). However, Hernández-Péon (70) and Sterman & Clemente (193) also report the existence of a cholinergic arousal system which may be related to the ventrally ascending cholinergic system described by Shute & Lewis (188).

In summary, the brain stem reticular formation is probably not the only structure that mediates phenomena associated with wakefulness, nor can it be assumed to uniformly facilitate or activate other brain processes (see discussions in 23, 180, 196). The rostral pontine and midbrain reticular formation do have crucial roles in the control of cortical rhythms both by direct reticulo-cortical activation and by modulating the nonspecific thalamic recruiting system. However, portions of the posterior hypothalamus appear to interact with midbrain reticular areas and perhaps have a major role in promoting the levels of muscle tonus and sympathetic activity which characterize wakefulness. As we shall see shortly, sleep, like wakefulness, is not a unitary state of consciousness for it involves the integrity of many more brain areas than those of the rostral brain stem.

SLEEP ONSET

Our review of the phenomenology of sleep supports the notion that the transition from waking to sleep represents a dramatic shift in patterning or organization of most somatic, autonomic, and CNS processes. Such changes in the various functional units may be brought about by passive defacilitation, by disinhibition and resulting activation, or by active inhibition of the various brain mechanisms governing sleep and waking. Kleitman (105) argued that sleep onset is a passive phenomenon in that maintenance of wakefulness is governed by the magnitude of afferent input to the CNS. Thus reduction of afferent input beyond some critical level results in sleep onset. Initial support for this point of view came from the classic experiment of Bremer (22) in which transection of the brain stem at the midcollicular level (*cerveau isolé* preparation), permitting only olfactory and optic inputs to reach the forebrain, produced both cortical EEG and autonomic signs of sleep. A later formulation of the passive theory of sleep onset came from the discovery of the arousal properties of the brain stem reticular formation (116, 139). According to this version of the passive theory, a reduction of afferent inputs to this system leads to sleep onset. The central problem for advocates of the passive view is the existence of certain mechanisms in the brain which actively induce sleep or sleep-like states.

Active brain stem mechanisms.—The persistence of cortical desynchrony in the midpontine pretrigeminal preparation (13) suggested that a synchronizing mechanism located in the caudal pons may act to inhibit the rostral brain stem structures which mediate cortical desynchrony. A series of studies (28, 177) showed that hemisections in the rostral pons and midbrain produced asymmetrical cortical spindles (greater initial synchrony on the side ipsilateral to the lesion) during sleep and asymmetrical desynchrony (greater desynchrony on the side ipsilateral to the lesion) during waking. Such asymmetrical cortical rhythms were not observed in animals with hemisections in the caudal pons or rostral medulla. These results suggested that a synchronizing structure was located near the medullary-pontine junction. Magni et al (123) examined pharmacologically the role of this lower brain stem synchronizing mechanism, showing that intravenous injections of a barbiturate normally produced cortical synchronization, but that limiting the distribution of the drug to the lower brain stem produced a desynchronized EEG. Presumably, such selective depression of synchronizing structures in the lower brain stem releases the rostral reticular formation from some tonic inhibitory influence. Rossi (176) cites evidence that this pontine cortical synchronizing region is chronically active, whereas medullary synchronizing regions are phasically active. While the interaction of these brain stem synchronizing regions with the activating portion of the midbrain reticular formation are exceedingly complex, there are indications that the facilitation of cortical EEG synchrony produced by the pontine region is largely due to inhibition of the midbrain reticular formation, whereas the medullary region near the nucleus of the solitary tract may act directly to trigger the thalamocortical synchronizing system (20). Synchronization of the EEG which can be obtained by stimulation of the orbital cortex may be mediated by the medullary reticular formation which receives many fibers from that area (34).

Many studies have demonstrated the depressor effects of the bulbar reticular formation on both motor activity and EEG (e.g. 34, 134). Dell (33) suggested that this bulbar inhibitory area is sensitive to both motor and autonomic changes of the body, that it can "accumulate" the inhibitory effects resulting from these changes, and that sleep results from an excessive accumulation of these effects. Dell's theory contains both active and passive mechanisms in that where bulbar activity reaches a certain level, if nothing disturbs the resulting deactivation of the midbrain reticular formation, sleep ensues and is self-maintained.

Finally, Jouvet (90) presents evidence for reticular deactivation via a system of midline serotonergic neurons (the raphe nucleus) extending from the medulla to the caudal mesencephalon. Jouvet argues that this system of ascending fibers is responsible for the triggering of events leading to NREM sleep. However, Harper & McGinty (61) have presented data showing that cells (presumably serotonergic) within the raphe nucleus display a decrease in firing during NREM sleep relative to waking and an even greater decrease in firing during REM sleep. These authors suggest that serotonergic raphe cells may participate in constraining activities which interfere with sleep, thus playing a role on its onset but not its maintenance.

Active thalamic and cortical mechanisms.—In 1942, a group of thalamic nuclei (collectively called the "nonspecific thalamic nuclei" and including the intralaminar, midline, reticular, and certain other nuclei) were found to have a powerful synchronizing influence on cortical rhythms (42, 133). Generally, the so-called thalamic recruiting response can be elicited by low-frequency stimulation of these thalamic nuclei or of even the midbrain reticular nuclei (198). The dorsal limb of the ascending group of brain stem reticular fibers invades the midline and intralaminar nuclei of the thalamus. Several studies now suggest that corticopetal projections from the nonspecific thalamic nuclei are mediated by the ventral anterior thalamic nucleus (185, 186, 206). Among the cortical regions which appear to be an important target for fibers from the nonspecific thalamic system is the orbital cortex, which has been found to have powerful inhibitory effects on motor and autonomic function (95) and which is thought to inhibit certain reflexes via its connections with other inhibitory areas of the lower brain stem (182).

A number of investigators have implicated the nonspecific projection system in both cortical depression and sleep mechanisms (124). Hess (73) found that low-frequency stimulation of a midline thalamic area near the massa intermedia elicited sleep-like behavioral states in cats, including many presomnolent activities. Replications of these findings confirmed a striking similarity between the behavioral and EEG properties of natural sleep and the state produced by electrical stimulation of the medial thalamus and other parts of the nonspecific thalamic system (108, 193).

Several investigators regard the medial thalamic region as an integrative center for sleep processes. Koella (107, 108) sees sleep mechanisms as organized in a hierarchical fashion with a sleep center proper controlling several subordinate structures which mediate the various symptoms of sleep. The supraordinate structures are the intralaminar and other thalamic nuclei of the nonspecific projection system, whose activation produces not only long periods of behavioral sleep but also organizes presomnolent behaviors conducive to relaxation and to a reduction in sensory input to the CNS. The basal forebrain structures, including the anterior hypothalamus, are viewed as part of the subordinate sleep controlling apparatus, perhaps organizing autonomic and skeletal muscle tone. The medullary and pontine inhibitory structures would participate in sleep induction via removal of tonic inhibition transmitted from more rostral areas of the brain.

Virtually all active brain mechanisms alleged to participate in sleep onset do so, at least in part, by reducing activity in those neural regions (e.g. midbrain reticular formation) critical for the maintenance of waking. However, one of the most perplexing findings for the reticular hypothesis of waking and sleep has been that the average firing rates of most neurons of the cortex and brain stem are not markedly reduced during sleep (48). Instead, most units show high-frequency burst patterns and, during REM sleep, very high discharge rates. Evarts (48) has proposed an interesting hypothesis concerning the role of certain cortical neurons in the sleep induction process. He suggests that during waking cortical cells cannot fire faster than some maximum rate because of the action of cortical inhibitory neurons similar to the Renshaw cells of the spinal cord. Strychnine, a drug which blocks the inhibitory action of spinal Renshaw cells to produce high rates of motor neuron discharge, also causes high discharge rates in single cortical neurons when applied to the cortex. In view of the similarity of burst patterns found in sleep and with application of strychnine to the cortex, Evarts suggests that the firing patterns of cortical cells during sleep may result from defacilitation of some cortical analog of the Renshaw cell. Moruzzi (137) extends certain aspects of this hypothesis, suggesting that during waking cortical interneurons are involved in the mediation of "plastic" events (such as learning, attention, or vigilance) and that they require relatively long periods of quiescence to recover from these activities. It is difficult to see how such a mechanism could account for all the array of sleep phenomena unless it were somehow operative at all levels of neural organization. Unfortunately, Renshaw-like interneurons, if they do exist above the spinal level, would be exceedingly difficult to isolate with currently available microelectrodes.

Active basal forebrain mechanisms.—Perhaps the earliest systematic studies of structures capable of influencing sleep onset concerned the anterior hypothalamus and other basal forebrain structures whose functions were considered antagonistic to those of the posterior hypothalamic and midbrain reticular waking mechanisms. Generally, lesions of the anterior hypothalamic area caused insomnia, whereas posterior hypothalamic damage resulted in hypersomnia (45, 143). Recent studies confirming increased waking after anterior lesions have been extensive (see 193). Lesions of the rostral preoptic area and basal portion of the diagonal band of Broca also resulted in increased waking and decreased sleeping times (122). Moreover, lesions in many of the forebrain areas thought to be essential for the normal expression of sleep also impaired response inhibition and produced behavioral excitability (72, 128). However, in cats, where lesions of basal forebrain structures produced a fragmented sleep-waking cycle, the basic rest-activity cycle as determined by recurrent REM epochs and performance apparently remained intact (194).

Electrical stimulation studies provide data complementary to the results of the lesion studies (193, 194). Stimulation of preoptic and adjacent forebrain areas with a wide range of frequencies can induce sleep or sleep-like states after only brief delays. These basal forebrain regions apparently represent one of the few brain loci from which both EEG synchrony and behavioral sleep can be induced with high-frequency stimulation. It is in part on the basis of the latter finding that Sterman & Clemente (193, 194) assert that the basal forebrain and not other diencephalic structures (as argued by Koella) are the principal organizers of brain processes at sleep onset. Even animals highly motivated by aversive or appetitive conditioning procedures become drowsy or show signs of behavioral sleep when stimulated in a variety of basal forebrain structures (193). Not only is instrumental performance suppressed with such stimulation but so are brain stem and spinal reflexes, presumably by forebrain-induced postsynaptic inhibition.

Injections of acetylcholine, eserine, or carbachol into the preoptic region and other portions of the basal forebrain generally have been found to induce a kind of somnolent state resembling sleep (70, 193), although there is at least one study in which liquid carbachol produced arousal (121). At least two other substances injected into the preoptic area produced EEG synchronization and behavioral sleep: serotonin (219) and progesterone (75). Apparently, however, intermixed with basal forebrain neurons involved in sleep induction are neurons mediating behavioral and EEG activation since norepinephrine injected into the caudal preoptic region causes these latter effects (71, 219). On the basis of existing data, both serotonin and acetylcholine in forebrain regions appear to induce sleep phenomena, whereas norepinephrine as well as certain cholinergic compounds induce some aspects of arousal. Possibly an extrapolation of the Burn & Rand hypothesis (25) that cholinomimetics act to promote the release of other neural transmitters would account for these effects. In such a case, basal forebrain arousal effects might be mediated by norepinephrine and sleep-induction effects by serotonin.

Finally, studies on thermal stimulation of the basal forebrain region show that cooling of the anterior hypothalamus produces significant activation of the animal (142), while warming of this area causes relaxation, drowsiness, and sleep (175). DeArmond & Fusco (32) found that sleep brought about by warming of the preoptic area was accompanied by a reduction in spontaneous and elicited activity in the midbrain reticular formation. Such data argue for a direct or indirect inhibition of midbrain reticular processes by activity initiated in the basal forebrain. On the latter point, Harper & McGinty (61) found that preoptic cells which displayed an irregular, slow pattern of firing during waking showed a marked increase in discharge rate at the occasion of sleep onset. Once sleep spindles occurred, these cells returned to their presleep firing patterns.

Sterman & Clemente (194) suggest that basal forebrain structures organize and integrate most of the central manifestations which characterize the shift from waking to sleep. This region becomes specifically active at the onset of sleep and acts via its projections to thalamus, midbrain, and lower brain stem regions to terminate or reduce ongoing behaviors, elicit resting postures, reduce corticopetal discharge, and block afferent volleys.

Finally, how do thalamic and other forebrain structures interact with brain stem structures in the production of sleep? Pompeiano & Swett (160) found that EEG synchronization and often behavioral sleep could be induced by low-frequency stimulation of cutaneous fibers, which ascend in the spinoreticular tract and which synchronize activity in the nucleus reticularis gigantocellularis (164). Afferents from the latter bulbar structure like those from the solitary tract (which also produces stimulation-elicited EEG synchrony) are known to innervate the nonspecific thalamic nuclei (23). Furthermore, as mentioned earlier, the EEG synchronization induced by stimulation of the orbital cortex may be mediated by medullary structures (34). Thus, forebrain as well as peripheral influences on certain manifestations of sleep may depend in part on bulbar inhibitory structures which in turn play upon nonspecific thalamic nuclei.

Jouvet (90) maintains that an ascending system of serotonergic fibers originating in the brain stem raphe nucleus is responsible for triggering the onset of cortical features of NREM sleep and presumably sleep onset. However, Sterman & Clemente (194) cite evidence for a reciprocal organization between the dorsal raphe nuclei and the basal forebrain region in which feedback modulation of the serotonergic raphe system is mediated by descending elements from the basal forebrain. Dement (37) also maintains that serotonergic systems act to constrain waking behaviors which normally interfere with sleep. The relative extent to which the basal forebrain structures directly suppress waking mechanisms in the midbrain or do so indirectly by activating bulbar inhibitory processes is still unclear (see 117).

It should be evident that in the attempts to integrate the various facts concerning the participation of neural structures in the transition from waking to sleep, no theory to date is completely satisfactory. Part of the problem derives from the likelihood that there is not a single brain system whose activity or function is not altered in some fashion with the onset of sleep. Furthermore, it is becoming increasingly clear that the character of such change may often be qualitative and subtle, e.g. a shift in the patterning of unit firing, a shift in the dominance of one system over another, etc. Both active and passive mechanisms participate in the induction of sleep, although it now appears that some so-called active mechanisms may participate by the damping of activities which interfere with sleep as well as by direct inhibition of the reticulo-cortical waking system.

Mechanisms Responsible for Various Stages of Sleep

Most investigators have attempted to account for those neural processes underlying the two most prominent patterns of sleep activity—REM and NREM sleep—and generally have concluded that these two types of sleep are qualitatively different. In this section we will briefly review mechanisms responsible for REM sleep and for the processes governing alternations between REM and NREM sleep.

NREM mechanisms.—Statements concerning mechanisms for sleep onset generally are also applicable to NREM sleep. That is, the most prominent electrographic signs of sleep onset are the emergence of cortical slow waves and spindles which characterize NREM sleep. There is evidence, however, that the mechanisms which mediate slow waves and spindles are not identical. For example, Jouvet (90) cites studies showing that the thalamus is essential for the occurrence of cortical spindles but not for cortical slow waves. When the entire cortex is removed, synchronized activity in subcortical structures is abolished (89). However, if only a small portion of the orbital gyrus is left undamaged in subtotally decorticated cats, reticular slow waves still appear. The replication of this finding by Velasco & Lindsley (200) strengthens the notion that the orbital cortex may play a crucial role in subcortical synchronization during slow-wave sleep.

REM mechanisms.—Most of the recent studies of REM mechanisms can be divided into those examining tonic features of the REM state such as muscle atonia and cortical desynchrony and those addressed to phasic features of REM such as rapid eye movements, autonomic irregularities, and PGO spikes. Jouvet (89) showed that structures essential for the periodic manifestations of the behavioral and EEG signs of REM sleep were located in the pons. Although destruction of the nucleus centralis superior de Betcherew and of the medial part of the NRPO and nucleus reticularis pontis caudalis (NRPC) did not affect either state of sleep, lesions of caudal aspects of the NRPO and of the rostral portion of the NRPC suppressed REM sleep in cats. Acute pontile preparations with hypothalamic islands continue to show alterations between "waking" and periods of muscle atonia similar to those of REM sleep without any signs of an intermediate (i.e. NREM) sleep stage (92).

Bilateral lesions of the dorsal part of the medio-lateral pons, including the *locus coeruleus* and zones immediately medial and ventral to it, reduced the tonic muscle atonia of REM without affecting the phasic occurrence of PGO spikes (92). Dement (38) has suggested that the activation of cortical and pyramidal systems seen during REM sleep involves an elaboration of motor output which is normally inhibited by mechanisms located in the *locus coeruleus*. Lesions of the *locus coeruleus* produced phasic, fully produced, fully organized behavior patterns during which the animal seemed oblivious to environmental stimuli. It is not certain which structures interact with the *locus coeruleus* in the supraspinal, inhibitory control of muscle tonus during REM, but bulbar structures are probably involved. The *locus coeruleus* and areas ventral to it are rich in noradrenergic neurons (76), which may be part of the diffuse mesencephalic pathways that mediate tonic cortical activation during REM, and of the ascending pathway through the septum which mediates the hippocampal theta rhythms also found tonically during REM episodes.

The medial and descending vestibular nuclei are probably essential for most of the phasic inhibitory and active events seen during REM sleep (159). Descending phasic influences are mediated via the dorsolateral funiculi of the spinal cord. Pompeiano and co-workers (159) conducted an elegant set of experiments detailing the nature and mechanisms of reflex inhibition and of altered sensory conduction during both the tonic and phasic aspects of REM. While lesions of the medial and descending vestibular nuclei abolished bursts of rapid eye movements as well as the phasic increases in pyramidal discharge and related muscular contractions, tonic signs of REM sleep, cortical desynchrony, and muscular atonia were intact.

Thus the medio-lateral pons and related structures appear to contain many of the effector mechanisms responsible for the production of the complex array of electrographic and behavioral signs characterizing stage REM. Jouvet (91) asserts that stimulation of the NRPC may precipitate a REM episode but that the occurrence of a stimulation-elicited REM epoch is contingent on certain biochemical factors related to the state of serotonergic and noradrenergic neurons. For Jouvet (91), the NRPC also plays a crucial role in the development of cortical desynchrony during REM. Jouvet & Michel (93) suggested that fibers from this pontine region project to cortical areas via a "limbic midbrain" route. Rossi et al (178), however, found that extensive lesions of these pathways did not disrupt cortical desynchrony during REM. Phasic phenomena such as PGO spikes appear to be part of an ascending system dependent upon the integrity of the NRPC (77).

Problematic for Jouvet's pontine REM sleep center is the finding that virtually all pontine structures must be eliminated in order to prevent the appearance of the desynchronized REM sleep pattern at the cortex (see discussion in 107). Moreover, where Jouvet sees the pontine mechanisms as primary in the triggering of REM episodes, other investigators (105, 188, 195) assert that other forebrain mechanisms can modulate the pontine mechanisms. Not only are certain peripheral features of REM sleep altered by removal of forebrain structures (82), but both mono- and polysynaptic reflexes which are normally depressed during REM sleep are tonically facilitated by removal of forebrain structures (84).

In summary, the electrical manifestations of REM sleep are both exceedingly complex and qualitatively different from wakefulness and NREM sleep. Mechanisms in the pons appear to be essential for both the tonic and phasic ascending activity which produces the cortical desynchrony and intense unit firing seen in the hypothalamus and pyramidal system and the more transitory phenomena such as PGO spikes. This intense activation is prevented from expressing itself in tonic motor activity by bulbar inhibitory mechanisms also triggered by pontine activity. All of these brain systems may be modulated by activity in forebrain structures.

Mechanisms governing the REM-NREM or rest-activity cycle.—The processes which mediate the alternation between REM and NREM sleep are not yet understood. Jouvet (90) argued that the regular periodicity of REM signs in pontine preparations implies the existence of an autonomous regulating system at the level of the pons which governs the ultradian cycle of REM periods. He (91) hypothesized dual sleep centers, a NREM system located in the serotonergic neurons of the raphe nuclei, and a "three-key" neurochemical system located in and near the *locus coeruleus* of the pons. Jouvet's position will be discussed later in this review.

Several other investigators have suggested dualistic theories for the alternation between REM and NREM sleep (46, 56, 219). Yamaguchi and his co-workers suggest that a balance between adrenergic arousing and serotonergic/cholinergic sleep-inducing neurons in subcortical areas of the brain account for shifts in the patterns of sleep symptoms. Ephron & Carrington (46) proposed a homeostatic theory wherein deepening NREM sleep reaching some preset level triggers a tendency toward REM sleep and organismic activation. This latter notion is compatible with the argument for forebrain modulation of REM episodes. It should be clear from this review that our current understanding of the effector processes necessary for certain of the symptoms of sleep is much more advanced than our understanding of the mechanisms governing shifts from waking to sleep or from NREM to REM sleep.

SLEEP NEUROCHEMISTRY

Since short-term neuronal mechanisms, measured in milliseconds, are not compatible with the long-term circadian and ultradian rhythmicity of sleep states, neurohumoral mechanisms have received increasing attention. The search for so-called "hypnogenic" substances is not new. More than 50 years ago it was demonstrated that nonfatigued recipient dogs could be made drowsy by intraventricular injection of cerebrospinal fluid (CSF) from fatigued dogs, whereas dogs receiving CSF from nonfatigued donors showed no such effects (154). More recently, however, although these results were replicated, their interpretation was questioned because changes in spinal fluid pressure and body temperature were found in the recipients (187). Monnier & Hosli (132) reported that venous dialysate from sleeping rabbits induced sleep in alert recipients while dialysate from an alert donor aroused a sleeping animal. These studies do suggest the presence of a "hypnogenic" substance in the CSF or blood of sleeping animals, although its identity is not known. The fact that Siamese twins with a common circulatory system can have independent sleep-waking cycles (152) has been cited as evidence against the existence of humoral hypnogenic substances. However, as Kleitman (105) pointed out, the state of the nervous system would probably determine its response to circulating hypnogens. Thus one brain might be depressed to the point of vulnerability to the hypnogen while the other was not.

Though many naturally occurring central nervous system substances are capable of inducing sleep, recent research suggests that certain biogenic amines, particularly serotonin (5-HT) and norepinephrine (NE) are especially important for the induction and maintenance of the stages of sleep. These monoamines are found in high concentrations in the hypothalamus, midbrain, and brain stem, areas which are critical for the control of sleep. By means of fluorescent histochemical techniques, "mapping" of the chemical localization of 5-HT and NE in the brain has been possible (76). Most serotonin-containing neurons are located within the midline raphe nuclei of the medulla, pons, and lower midbrain. Cells rich in norepinephrine are found somewhat more laterally, in the medullary and pontine reticular formation, a portion of this latter system, the *locus coeruleus*, being particularly rich in NE. The terminals of these noradrenergic and serotonergic neurons are widely distributed throughout the brain stem, diencephalon, neocortex, and hypothalamus. Others are found in the dorsal and ventral horns as well as the lateral columns of the spinal cord. The pineal gland also contains a high concentration of serotonin.

Data are contradictory and opinions differ concerning which of these neurohumors is specifically associated with what stage of sleep. Attempts to elucidate their roles are necessarily indirect, since neither 5-HT nor NE passes the blood-brain barrier. Thus most investigators have relied on precursors of the biogenic amines which do cross into the brain or on pharmacological agents which modify the synthesis, transport, storage, or metabolism of the monoamines. Based on such studies, Jouvet (91) proposed a biochemical model of sleep control in which the occurrence of NREM sleep depends upon brain levels of 5-HT, while the induction of REM sleep depends on the combined action of a serotonin metabolite, norepinephrine and acetylcholine (ACh).

NREM SLEEP MECHANISMS

The hypothesis that NREM sleep is mediated by serotonergic processes is supported by brain lesion as well as pharmacological studies. For example, a state of behavioral and EEG insomnia occurs following destruction of 80–90% of the raphe system (91). A significant fall in cerebral serotonin also occurs following such lesions, while cerebral NE remains unchanged. Partial lesions of the raphe system result in more or less pronounced insomnia depending on their extent, and REM sleep occurs only if NREM exceeds 20% of a 24-hr record. Lesions which destroy less than 15% of the raphe system produce no significant changes in sleep. There is, therefore, a systematic relationship between the extent of destruction of the raphe system, the associated decrease in cerebral 5-HT, and the degree of insomnia. Intracarotid injection of 5-HT itself produces a biphasic EEG pattern consisting of an initial ½–2 min arousal pattern followed by prolonged cortical hypersynchrony. An extra blood-brain barrier region of the fourth ventricle, the area postrema, is apparently involved, because its surgical destruction prevents the 5-HT effect (107).

Since peripherally administered 5-HT crosses into the brain poorly, the 5-HT precursors, 5-hydroxytryptophan (5-HTP) and L-tryptophan have been employed to raise brain serotonin levels. The administration of 5-HTP by intravenous or intraperitoneal routes potentiates NREM sleep and suppresses stage REM in the cat (90). Similarly, moderate (around 7.5 g) doses of L-tryptophan, precursor of 5-HTP, increase NREM sleep in man (59, 217). Reserpine, which interferes with storage of biogenic amines and depletes the brain of both 5-HT (156) and the catecholamines (83), causes prolonged insomnia in cats; NREM sleep recovers in about 2 days, while REM may be absent as long as 4 days. However, an injection of 5-HTP in the reserpinized cat will immediately restore NREM sleep (91). Parachlorophenylalanine (PCPA), an inhibitor of the enzyme tryptophan hydroxylase, blocks the synthesis of 5-HT, while leaving brain levels of the catecholamines relatively unaffected. PCPA produces insomnia in cats and rats, lasting as long as 36 hr, which is followed by slow recovery of both stages of sleep. The decrease and recovery of NREM sleep parallels the decrease and recovery of cerebral serotonin (91). In monkeys, total sleep time is reduced following PCPA, but this is due primarily to a decrease in NREM rather than REM sleep (208). When 5-HTP is injected into PCPA-treated cats, NREM sleep is immediately restored (90). Thus the bulk of evidence from both animals and humans supports the view that the induction and maintenance of NREM sleep are regulated by serotonin levels in the brain. There are data, however, which challenge this notion. Dement et al (39) found that with repeated doses of PCPA to cats, causing prolonged depletion of brain 5-HT, total insomnia was a transient phenomenon. Within a week, in the chronic PCPA animal, both NREM and REM sleep returned nearly to baseline levels. However, the PGO spikes associated with REM periods were now present throughout the 24-hr recording period, regardless of the background EEG state. Further, Wyatt's (217) studies suggest that alterations in sleep produced by L-tryptophan may be associated with metabolic routes other than the 5-HT pathway. For example, L-tryptophan potentiated NREM sleep either in normal or in PCPA-treated humans. Since for the latter group the pathway to serotonin was presumably blocked by inhibition of tryptophan hydroxylase, the enhancement of NREM sleep must have resulted from some other metabolic process. Finally, the finding by Harper & McGinty (61) that firing rates of single neurons in the raphe system are reduced during sleep may embarrass Jouvet's model. That is, assuming that these units are serotonergic, it appears that serotonin release is reduced rather than enhanced during the onset and course of NREM sleep.

REM SLEEP MECHANISMS

Several of the 5-HT precursor studies particularly in humans, appear to implicate serotonin in REM rather than, or in addition to, NREM sleep. A number of experiments showed that 5-HTP given orally or intravenously to humans increased REM sleep (125, 150, 218). Further, PCPA administered to patients with carcinoid syndrome depressed REM rather than NREM sleep, an effect which could be reversed with 5-HTP (218). L-tryptophan also alters REM sleep. Moderate doses (in the 7.5 g range) potentiate REM sleep in humans primarily by decreasing REM onset latencies and accelerating REM periodicity (63, 150, 153). Hartmann (65) found a similar effect in rats where a tryptophan-free diet lengthened the period of REM-to-REM cycles, while a tryptophan-loaded diet increased the frequency of REM periods. On the whole, data from precursor-loading studies suggest that serotonergic processes are involved in the periodicity or triggering of REM, rather than in mechanisms controlling the duration of REM episodes.

The results of loading experiments are difficult to reconcile, however, with the consistent finding that reserpine, which reduces brain levels of the biogenic amines, also potentiates stage REM (29, 62, 81). Like the 5-HT precursors, reserpine accelerates the periodicity of stage REM and shortens the latency of initial REM onset. Coulter et al (29) suggested that reserpine and 5-HT precursors may have one effect in common, i.e. both enhance the synthesis and turnover of 5-HT. Thus the rate of synthesis and turnover of 5-HT or one of its metabolites may influence the cyclic occurrence of REM episodes. Jouvet's experiments with monoamine oxidase inhibitors (MAOI) led him to postulate a similar mechanism. Because the MAOIs, which in the cat specifically block the deamination of 5-HT, are associated with rapid and complete inhibition of REM sleep, Jouvet suggested that the action of some deaminated catabolite of serotonin might be necessary for the cyclic occurrence of REM periods (91). Assuming that 5-HT is involved in the mechanisms for NREM sleep, the fact that REM sleep is commonly preceded by NREM sleep is also consistent with this hypothesis. Although, as described, the findings with moderate doses of L-tryptophan support the idea that 5-HT synthesis and turnover accelerate the cyclic occurrence of REM episodes, certain problems are presented by a recent report (59) that high doses (12 g) of L-tryptophan also increase REM, but by increasing the duration of REM episodes. In this context, it may be important to note that increasing doses of L-tryptophan in the rat do not increase brain 5-HT beyond a certain maximum level. However, higher doses do prolong the duration of peak levels (131). Possibly the increased duration of REM episodes found with high doses of L-tryptophan is related to this effect.

As mentioned earlier, using evidence from neurophysiological, pharmacological and histochemical studies, Jouvet (91) proposed a "three-key" mechanism for the induction of REM sleep. In this model, "priming" serotonergic centers in the raphe nuclei act through a deaminated metabolite of 5-HT on cholinergic systems which then trigger the final noradrenergic mechanisms of stage REM, located in the *locus coeruleus*.

In support of this view, Jouvet asserts that NREM sleep is a necessary condition for the occurrence of stage REM, noting that the amount of REM sleep following either PCPA injection or partial destruction of the raphe system is closely related to brain levels of 5-HT. Further, surgical destruction of the NE-rich *locus coeruleus* in the cat's brain stem does eliminate the tonic, though not the phasic, components of stage REM. In reserpinized cats with chronic insomnia, injection of the NE precursor dihydroxyphenylalanine (DOPA) restored REM sleep (91). In the rat, depletion of NE by alpha-methyl-*p*-tyrosine, which blocks catecholamine synthesis, resulted in increased NREM and decreased REM. These effects were reversed by intracerebral injections of NE (199). Chronic dietary depletion of the NE precursors phenylalanine and tyrosine in man (113) also reduced stage REM, but this effect may have been due to distortions of protein synthesis resulting from deprivation of essential amino acids.

The principal objection to claims for a role of NE in the mechanisms of REM is that NE or its precursors, when administered to intact animals or humans, produces arousal and tends to suppress stage REM (71, 216). In fact, on the basis of pharmacological studies, both Hartmann (67) and Wyatt (218) concluded that the relation between REM sleep and brain NE is actually the inverse of that proposed by Jouvet, higher levels of NE being accompanied by decreased REM sleep.

There is also evidence that acetylcholine (ACh) has a role in the triggering of REM sleep. For example, injections of carbachol or ACh in the vicinity of the *locus coeruleus* trigger REM sleep in cats (57). Eserine facilitates REM sleep in pontine cats (89) whereas atropine administered to intact cats suppresses stage REM (89). Hernandez-Peon (71) reported that the application of crystalline ACh to punctate regions of the medial forebrain bundle of cats produced a state resembling REM, a finding which was confirmed in both cats and rabbits by Karczmar et al (99). The latter investigators observed that if eserine was administered to the reserpinized (thus monoamine depleted) animal, an EEG and behavioral syndrome emerged which was identical to REM sleep, with desynchronized EEG, hippocampal theta, PGO spiking, muscular atony, and frequent bursts of rapid eye movements. This effect was rapidly reversed by atropine, which returned the animal to the EEG synchrony and high EMG tonus of the reserpine syndrome. Hemicholinium-3 (HC-3) reduces subcortical (but not neocortical) ACh levels by blocking the active transport of choline needed for resynthesis of ACh. In cats, intraventricular HC-3 reduced the tonic but not the phasic aspects of REM (69).

Apparently, there are no methods available currently which could confirm or disprove the specific order of chemical events proposed for the three-key model. Further, the mechanisms by which the three factors are linked are not known. However, it will be recalled that in another context, Burn & Rand (25) proposed a theory in which ACh acts as a releaser for the noradrenergic transmitter. There is some evidence in support of this notion (99). There appears to be no direct evidence that a deaminated metabolite of 5-HT could serve as a priming mechanism for the release of ACh. On the basis of recent evidence from the labs of Sterman & Clemente, it has been suggested that during episodes of REM sleep, 5-HT neuronal stores are replenished perhaps specifically within the raphe system which appears to be maximally inhibited during REM episodes (130).

THE CIRCADIAN SLEEP-WAKEFULNESS CYCLE

Research on biological rhythms has recently demonstrated the circadian rhymicity of certain biogenic amines, the 24-hr cycling of 5-HT, NE, and melatonin in the pineal gland being the best-known example (162, 215). The circadian period of melatonin is controlled by light on the retina by way of brain-stem connections to adrenergic systems, and mediated through sympathetic nerves to the pineal. Exposing the animal either to total darkness, continuous light, or blinding will abolish the 24-hr rhythms of both NE and melatonin (10). In contrast, circadian rhythmicity of 5-HT is abolished only by continuous light (162). Norepinephrine circadian cycles have also been found in the hypothalamus and spinal cord of cats and rats (126, 170), and a 24-hr serotonin cycle was found in the cerebrum of rats (163). Weitzman (208) cites a personal communication from D. J. Reis which highlights the complexity of findings in this area. Apparently, different brain regions in the cat are out of phase for the same biogenic amine. Thus for some brain regions (e.g. hypothalamus) NE may have ultradian (less than 24-hr) cycles, whereas in other areas in the same animal (e.g. brain stem) NE has a circadian rhythm. Whether the circadian and ultradian cycles of amine levels are linked to circadian sleep-wakefulness cycles or to ultradian REM periodicity is not known, but future studies which correlate sleep physiology with biological rhythms will certainly enhance our understanding of the biochemical substrates of sleep.

In summary, the examination of the biochemical mechanisms of sleep is in an early stage. One reason for this is that techniques for discrete microbiochemistry in living brains are still being developed, and current methods are not adequate to the task. The investigator must apply his substances directly to the brain, remove them from the brain by cutting out their tissue substrates, or manipulate them from a distance via precursors, synthesis blockers, and the like. Obviously none of these methods permits normal physiological functioning. Further, compounds used to modulate levels of the target substances usually affect other related substances, or themselves have direct or indirect biological potency. As Resnick (172) pointed out, even PCPA, the present favorite of sleep researchers because of its "selective" depletion of 5-HT, has several drawbacks. For example, it inhibits phenylalanine hydroxylase as well as tryptophan hydroxylase. Though brain NE in the PCPA animal can still be synthesized from tyrosine, blood levels of phenylalanine increase, an effect which may alter protein synthesis in the brain. Such changes could affect the mechanisms controlling sleep. All things considered, it is remarkable that the crude techniques now available have worked to produce a fairly consistent body of data on the roles of the biogenic amines in sleep.

ADAPTIVE SIGNIFICANCE OF SLEEP

FUNCTIONS OF NREM SLEEP

Among the more venerable hypotheses about the adaptive significance of sleep, and one which seems straightforward, is that sleep is a period of recovery from the fatigue of waking activity. That is, for optimal recovery, neurons of the brain, like the skeletal muscles, require prolonged periods of inactivity each day. Prior to the discoveries of the last two decades, nearly all theorists, whether advocating active or passive doctrines for sleep mechanisms, could agree that sleep consisted of a marked reduction of activity of body and brain, a period during which unknown processes of recovery presumably occurred. However, as pointed out in previous sections, no neuronal populations have been found whose behavior during sleep resembles that of the fully relaxed muscle. Evarts, it will be recalled, suggested that the high-frequency burst patterns found in cortical neurons during sleep might result from prolonged defacilitation (i.e. rest) of some analog of the Renshaw cell. Extending this hypothesis, Moruzzi suggested that neuronal systems involved in higher nervous functions such as learning and memory might require long periods of rest. Presumably these would be small neurons or neuronal microstructures whose activities cannot be studied with techniques currently available.

Studies of total and partial sleep deprivation have not contributed much to our understanding of the functions of sleep. The specific rebound effects which follow loss of NREM or REM sleep imply a biological need for each stage, but animals and humans can be put on short sleep rations for very long periods without notable effects on vital physiological functions (see 39, 85, 105).

One fact which challenges the recovery theory of sleep is the lack of positive relationship between amount of waking activity and amount of sleep. Webb (205) asserts that either for individual differences or species differences, there appears to be a negative correlation between amount of waking and amount of sleeping over the 24-hr circadian cycle. Further, even the rebound effects found with prolonged sleep deprivation do not indicate anything like one-to-one makeup of the lost sleep (39, 211), The experimental analysis of sleep has not provided strong support for the notion that sleep is a process of recovery.

Another theory, first advanced by Claparede, suggests that we sleep not because we are intoxicated or exhausted but in order to prevent exhaustion (105, p. 349). Webb (205) proposed a similar hypothesis in a behavioral context. That is, sleep is an active process of behavioral immobility which aids in preventing nonadaptive, ineffective activity. "The behavior of organisms," he asserts, "is carefully geared through evolution to optimal time periods for food gathering, protection from natural predators, symbiotic temperature, and moisture conditions and the like." He then suggests that *nonactivity* may be equally effectively geared to the environment and to the capacities of the species such that nonresponding results in decreased danger, or decreased energy output, when energy expenditure would be minimally effective. Therefore, Webb believes that each species develops a circadian sleep-activity cycle which is adaptively keyed to its capacity and environment, thereby making optimal use of the conditions for its survival. As an ecological theory of circadian behavioral adaptation, Webb's hypothesis seems potentially capable of addressing such questions as why some species sleep at night and others during the day, why the correlation between amount of sleep and amount of wakefulness during 24 hr is negative, and how sleep-activity cycles are related to the broader field of biological rhythms.

FUNCTIONS OF REM SLEEP

Since the phenomenology and neural mechanisms of stage REM are qualitatively different from those of NREM sleep, it is generally supposed that their functions are different. There are several biological theories of the function of REM sleep, each of which addresses different aspects of its phenomenology (i.e. its contingent relation to NREM sleep, its high index in neonates or in species with binocular vision, its paradoxical physiological properties, or the effects of its deprivation). Thus it has been suggested that (*a*) REM sleep clears the brain of some product accumulated during NREM sleep; (*b*) it provides an endogenous source of stimulation to the developing brain of the neonate; (*c*) it innervates the brain in the specific service of depth perception; (*d*) it reorganizes neuronal firing patterns which have become disorganized during NREM sleep; (*e*) it serves an alerting function in preparation for mammalian flight or fight patterns; and (*f*) it provides a "safety valve" outlet for the discharge of drives which would otherwise discharge during waking. (For recent reviews of these and other hypotheses, see 38, 64, 87.) Hartmann (64) and Jones (87) point out that none of these hypotheses is necessarily incompatible with the others, and each may explain some of the diverse phenomena of stage REM.

In conclusion, it is reasonable to predict that during the next decade there will emerge from the sleep laboratories a general explication of the neural and humoral mechanisms by which the states of sleep in mammals are initiated, sustained, and terminated—the how of sleep. Obviously this theory will influence the content of more complete models which try to explain the biological functions of sleep—the why of sleep. However, the partial review given here indicates that the issues which challenge a complete explanatory theory are formidable. The theorist who would explain the adaptive significance of sleep encounters a syndrome whose physiological and behavioral manifestations are nearly as diverse as those of waking.

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LITERATURE CITED

1. Adametz, J. H. 1959. Rate of recovery of functioning in cats with rostral reticular lesions. *J. Neurosurg.* 16:85–98
2. Akert, K., Bally, C., Schade, J. P. 1965. Sleep mechanisms. *Progr. Brain Res.* 18:96–117
3. Allison, T., Goff, W. R. 1968. Sleep in a primitive mammal, the spiny anteater. *Psychophysiology* 5:200–1
4. Arduini, A., Berlucchi, G., Strata, P. 1963. Pyramidal activity during sleep and wakefulness. *Arch. Ital. Biol.* 101:530–44
5. Arduini, A., Hirao, T. 1959. On the mechanism of the EEG sleep patterns elicited by acute deafferentation. *Arch. Ital. Biol.* 97:140–55
6. Asahina, K. 1962. Studies on sleep: I, Paradoxical phase and reverse paradoxical phase in human subjects. *J. Physiol. Soc. Jap.* 24:443–50
7. Aserinsky, E. 1965. Two types of ocular motility occurring in sleep. *J. Appl. Physiol.* 8:1–10
8. Aserinsky, E. 1965. Periodic respiratory pattern occurring in conjunction with eye movements during sleep. *Science* 150:763–66
9. Aserinsky, E., Kleitman, N. 1953. Regularly occurring periods of eye motility, and concomitant phenomena, during sleep. *Science* 118: 273–74
10. Axelrod, J., Wurtman, R. J., Snyder, S. H. 1965. Control of hydroxyindole D-methyltransferase activity in the rat pineal gland by environmental lighting. *J. Biol. Chem.* 250:949–54
11. Baldridge, B., Whitman, R., Kramer, M. 1965. The concurrence of fine muscle activity and rapid eye movements during sleep. *Psychosom. Med.* 27:19–26
12. Batini, C., Magni, F., Palestini, M., Rossi, G. F., Zanchetti, A. 1959. Neural mechanisms underlying the enduring EEG and behavioral activation in the midpontine pretrigeminal cat. *Arch. Ital. Biol.* 97: 13–25
13. Batini, C., Moruzzi, G., Palestini, M., Rossi, G. F., Zanchetti, A. 1959. Effects of complete pontile transection on the sleep-wakefulness rhythm: the midpontine pretrigeminal preparation. *Arch. Ital. Biol.* 97:1–12
14. Benoit, O., Bloch, V. 1960. Seuil d' excitabilité réticulaire et sommeil profond chez le chat. *J. Physiol. Paris* 52:17–18
15. Berger, H. 1929. Über das elektroenkephalogramm des menschen. *J. Psychol. Neurol.* 40:160–79
16. Berger, R. J. 1961. Tonus of extrinsic laryngeal muscles during sleep and dreaming. *Science* 134:840
17. Berger, R. J. 1969. Oculomotor control: A possible function of REM sleep. *Psychol. Rev.* 76:144–64
18. Berger, R. J. 1969. The sleep and dream cycle. See Ref. 96, 17–32
19. Berlucchi, G., Moruzzi, F., Salvi, G., Strata, P. 1964. Pupil behavior and ocular movements during synchronized and desynchronized sleep. *Arch. Ital. Biol.* 102:230–44
20. Bonvallet, M., Allen, M. E. 1963. Prolonged spontaneous and evoked reticular activation following discrete bulbar lesions. *Electroencephalogr. Clin. Neurophysiol.* 15: 969–88
21. Brebbia, D. R., Paul, R. C. 1969. Sleep patterns in two species of Bat, *Myotis lucifugus* (Little Brown) and *Eptesicus fuscus* (Big Brown). *Psychophysiology* 6:229–30
22. Bremer, F. 1935. Cerveau isolé et physiologie du sommeil. *C. R. Soc. Biol. Paris* 118:1235–42
23. Brodal, A. 1969. *Neurological Anatomy in Relation to Clinical Medicine.* New York: Oxford Univ. Press. 807 pp.
24. Buendia, N., Goode, M., Sierra, G., Segundo, J. P. 1963. Responsiveness and discrimination during sleep. *Experientia* 19:208–9
25. Burn, J. H., Rand, M. J. 1965. Acetylcholine in adrenergic transmission. *Ann. Rev. Pharmacol.* 5:163–82
26. Candia, O., Favale, E., Giussani, A., Rossi, G. F. 1962. Blood pressure during natural sleep and during sleep induced by electrical stimulation of the brain stem reticular formation. *Arch. Ital. Biol.* 100:216–33
27. Cordeau, J. P. 1962. Functional organization of the brain stem retic-

ular formation in relation to sleep and wakefulness. *Rev. Can. Biol.* 21:113–25

28. Cordeau, J. P., Mancia, A. 1959. Evidence for the existence of an EEG synchronization mechanism originating in the lower brainstem. *Electroencephalogr. Clin. Neurophysiol.* 11:551–64
29. Coulter, J. D., Lester, B. K., Williams, H. L. 1971. Reserpine and sleep. *Psychopharmacologia* 19: 134–47
30. Creutzfeldt, O., Jung, R. 1961. Neuronal discharge in the cat's motor cortex during sleep and arousal. See Ref. 214, 131–70
31. Davis, H., Davis, P. A., Loomis, A. L., Harvey, E. N., Hobart, G. 1938. Human brain potentials during the onset of sleep. *J. Neurophysiol.* 1:24–38
32. DeArmond, S. J., Fusco, M. M. 1969. Electrophysiological and behavioral evidence for linkage between thermoregulatory and sleep-wake mechanisms. *Fed. Proc.* 28: 587
33. Dell, P. 1963. Reticular homeostasis and critical reactivity. *Progr. Brain Res.* 1:82–114
34. Dell, P., Bonvallet, M., Hugelin, A. 1961. Mechanisms of reticular deactivation. See Ref. 214, 86–102
35. Dement, W. C. 1958. Occurrence of low voltage, fast electroencephalogram patterns during behavioral sleep in cat. *Electroencephalogr. Clin. Neurophysiol.* 10:291–96
36. Dement, W. C. 1967. Sleep. In *Mammalian Hibernation III*, ed. K. C. Fisher et al, 175–99. Edinburgh: Oliver & Boyd
37. Dement, W. C. 1969. The biological role of REM sleep. See Ref. 96, 245–65
38. Dement, W. C. 1969. The biological role of REM sleep (circa 1968). See Ref. 96, 245–65
39. Dement, W. C., Cohen, H., Ferguson, J., Zarcone, V. 1970. A sleep researcher's odyssey: The function and clinical significance of REM sleep. In *The Psychodynamic Implications of the Physiological Studies on Dreams*, ed. L. Madow, L. H. Snow, 71–123. Springfield: Thomas. 167 pp.
40. Dement, W. C., Kleitman, N. 1957. Cyclic variations in EEG during sleep and their relation to eye movements, body motility, and dreaming. *Electroencephalogr. Clin. Neurophysiol.* 9:673–90
41. Dement, W. C., Rechtschaffen, A., Gulevitch, G. 1966. The nature of the narcoleptic sleep attack. *Neurology* 16:18–33
42. Dempsey, E. W., Morison, R. S. 1942. The production of rhythmically recurrent cortical potentials after localized thalamic stimulation. *Am. J. Physiol.* 135:293–300
43. Dreyfus-Brisac, C. 1964. The electroencephalogram of the premature infant and fullterm newborn: Normal and abnormal development of waking and sleeping patterns. In *Neurological and Electroencephalographic Correlative Studies in Infancy*, ed. P. Kellaway, I. Petersen, 186–207. New York: Grune & Stratton
44. Dreyfus-Brisac, C. 1968. Sleep ontogenesis in early human prematurity from 24 to 27 weeks of conceptual age. *Develop. Psychobiol.* 1:162–69
45. Economo, C. von 1929. Schlaftheorie. *Ergeb. Physiol.* 28:312–39
46. Ephron, H. S., Carrington, P. 1966. Rapid eye movement sleep and cortical homeostasis. *Psychol. Rev.* 73:500–26
47. Evarts, E. V. 1961. Effects of sleep and waking on activity of single units in the unrestrained cat. See Ref. 214, 171–82
48. Evarts, E. V. 1964. Temporal patterns of discharge of pyramidal tract neurons during sleep and waking in the monkey. *J. Neurophysiol.* 27:152–71
49. Evarts, E. V. 1967. Activity of individual cerebral neurons during sleep and arousal. See Ref. 102, 319–36
50. Feinberg, I. 1969. Effects of age on human sleep patterns. See Ref. 96, 39–52
51. Feldman, S. M., Waller, H. J. 1962. Dissociation of electrocortical activation and behavioral arousal. *Nature* 196:1320–22
52. Fisher, C. 1965. Psychoanalytic implications of recent research on sleep and dreaming. *J. Am. Psychoanal. Assoc.* 13:197–303
53. Fisher, C., Gross, J., Zuch, J. 1965. Cycle of penile erection synchronous with dreaming (REM) sleep.

Preliminary report. *Arch. Gen. Psychiat.* 12:29–45

54. Foulkes, W. D. 1966. *The Psychology of Sleep.* New York: Scribner. 265 pp.
55. Gastaut, H., Lugaresi, E., Berti Ceroni, G., Coccagna, G., Eds. 1968. *The Abnormalities of Sleep in Man.* Bologna: Swets & Zeitlinger, Amsterdam. 326 pp.
56. Gellhorn, E. 1967. *Principles of Autonomic-somatic Integrations: Physiological Basis and Psychological and Clinical Implications.* Minneapolis: Univ. Minnesota Press. 314 pp.
57. George, R., Haslet, W., Jenden, D. 1964. A cholinergic mechanism in the brainstem reticular formation: Induction of paradoxical sleep. *Int. J. Neuropharmacol.* 3:541–52
58. Greenburg, R., Kelty, M., Dewan, E. 1969. Sleep patterns in the newly hatched chick. *Psychophysiology* 6:226–27
59. Griffiths, W. J., Lester, B. K., Coulter, J. D., Williams, H. L. 1972. Tryptophan and sleep in young adults. *Psychophysiology* 9:345–56
60. Hall, C. 1966. *The Meaning of Dreams.* New York: McGraw-Hill. 2nd ed. 240 pp.
61. Harper, R. M., McGinty, D. J. 1972. A technique for recording single neurons from unrestrained animals. *Brain Unit Activity During Behavior*, ed. M. I. Phillips. Univ. Iowa Press. In press
62. Hartmann, E. 1966. Reserpine: Its effect on the sleep-dream cycle in man. *Psychopharmacologia* 9:242–47
63. Hartmann, E. 1967. The effect of L-tryptophan on the sleep-dream cycle in man. *Psychon. Sci.* 8(11):479–80
64. Hartmann, E. 1967. *The Biology of Dreaming.* Springfield: Thomas. 206 pp.
65. Hartmann, E. 1967. The sleep-dream cycle and brain serotonin. *Psychon. Sci.* 8(7):295–96
66. Hartmann, E. 1969. Mania, depression, and sleep. See Ref. 96, 183–91
67. Ibid. Antidepressants and sleep: Clinical and theoretical implications, 308–16
68. Hawkins, D. R., Puryear, H. B., Wallace, C. D., Deal, W. B., Thomas, E. S. 1962. Basal skin resistance during sleep and "dreaming." *Science* 136:321–22
69. Hazra, J. 1970. Effect of Hemicholinium-3 on slow-wave and paradoxical sleep of cat. *Eur. J. Pharmacol.* 11:395–97
70. Hernández-Péon, R. 1962. Sleep induced by localized electrical or chemical stimulation of the forebrain. *Electroencephalogr. Clin. Neurophysiol.* 14:423–24
71. Hernández-Péon, R., Chávez-Ibarra, G., Morgane, J. P., Timo-Iaria, C. 1963. Limbic cholinergic pathways involved in sleep and emotional behavior. *Exp. Neurol.* 8:93–111
72. Hernández-Péon, R., Sterman, M. B. 1966. Brain functions. *Ann. Rev. Psychol.* 17:363–94.
73. Hess, W. R. 1944. Das schlafsyndrom als folge dien ephaler reizung. *Helv. Physiol. Pharmacol. Acta* 2:305–44
74. Hess, R., Koella, W. P., Akert, K. 1953. Cortical and subcortical recordings in natural and artificially induced sleep in cats. *Electroencephalogr. Clin. Neurophysiol.* 5:75–90
75. Heuser, G., Ling, G. M., Kluver, M. 1967. Sleep induction by progesterone in the pre-optic area in cats. *Electroencephalogr. Clin. Neurophysiol.* 22:122–27
76. Hillarp, N. A., Fuxe, K., Dahlstrom, A. 1966. Demonstration and mapping of central neurons containing dopamine, noradrenalin, and 5-hydroxytryptamine and their reactions to psychopharmaca. *Pharmacol. Rev.* 18:727–41
77. Hobson, J. A. 1965. The effects of chronic brain-stem lesions on cortical and muscular activity during sleep and waking in the cat. *Electroencephalogr. Clin. Neurophysiol.* 19:41–62
78. Ibid 1967. Electrographic correlates of behavior in the frog with special reference to sleep. 22:113–21
79. Hodes, R., Dement, W. C. 1964. Depression of electrically induced reflexes ("H-reflexes") in man during low voltage EEG "sleep." *Electroencephalogr. Clin. Neurophysiol.* 17:617–29
80. Hodes, R., Suzuki, J. 1965. Comparative thresholds of cortex, vestibular system and reticular formation in wakefulness, sleep and rapid eye movement periods. *Electroencephalogr. Clin. Neurophysiol.* 18:239–48.

81. Hoffman, J. S., Domino, E. F. 1969. Comparative effects of reserpine on the sleep cycle of man and cat. *J. Pharmacol. Exp. Ther.* 170:190–98

82. Holmes, J. E., Busacca, W. 1971. Prolonged wakefulness maintained by electrical stimulation of the brain. In *Neuroelectric Research*, ed. D. V. Reynolds, A. E. Sjoberggled, 214–20. Springfield: Thomas

83. Holzbauer, M., Vogt, M. 1956. Depression by reserpine of the noradrenaline concentration in the hypothalamus of the cat. *J. Neurochem.* 1:8–11

84. Iwamura, Y., Sterman, M. B., McGinty, D. J. 1969. Spinal and brainstem reflex activity during paradoxical sleep in brain transected cats. *Physiologist* 12:260

85. Johnson, L. C. 1969. Physiological and psychological changes following total sleep deprivation. See Ref. 96, 206–20

86. Johnson, L. C., Lubin, A. 1966. Spontaneous electrodermal activity during waking and sleeping. *Psychophysiology* 3:8–17

87. Jones, R. M., Ed. 1970. *The New Psychology of Dreaming.* New York: Grune & Stratton. 221 pp.

88. Jouvet, D., Valatx, J. L., Jouvet, M. 1961. Etude polygraphique du sommeil du chaton. *C. R. Soc. Biol. Paris* 155:1660–64

89. Jouvet, M. 1962. Recherches sur les structures nerveuses et les mécanismes responsables des differentes phases du sommeil physiologique. *Arch. Ital. Biol.* 100:125–206

90. Jouvet, M. 1967. Neurophysiology of the states of sleep. *Physiol. Rev.* 47:117–77

91. Jouvet, M. 1969. Biogenic amines and the states of sleep. *Science* 163:32–41

92. Jouvet, M., Delorme, F. 1965. Locus coeruleus et sommeil paradoxal. *C. R. Soc. Biol.* 159:895–99

93. Jouvet, M., Michel, F. 1958. Recherches sur l'activité électrique cérébrale au cours du sommeil. *C. R. Soc. Biol.* 152:1167–70

94. Jouvet, M., Michel, F., Mourier, D. 1960. Analyse électroencéphalographique comparée du sommeil physiologique chez le chat et chez l'homme. *Rev. Neurol.* 103:189–204

95. Kaada, B. R. 1960. Cingulate, posterior orbital, anterior insular, and temporal pole cortex. *Handbk. Physiol. Sect. 2 Neurophysiology,* 1345–72

96. Kales, A., Ed. 1969. *Sleep: Physiology and Pathology.* Philadelphia: Lippincott. 360 pp.

97. Kales, A., Tan, T. 1969. Sleep alterations associated with medical illnesses. See Ref. 96, 148–57

98. Karacan, I., Goodenough, D. R., Shapiro, A., Starker, S. 1966. Erection cycle during sleep in relation to dream anxiety. *Arch. Gen. Psychiat.* 15:183–89

99. Karczmar, A. G., Longo, V. G., Scotti De Carolis, A. 1970. A pharmacological model of paradoxical sleep: The role of cholinergic and monamine systems. *Physiol. Behav.* 5:175–82.

100. Kawamura, H., Witmoyer, D. I., Sawyer, C. H. 1966. Temperature changes in the rabbit brain during paradoxical sleep. *Electroencephalogr. Clin. Neurophysiol.* 21:469–77

101. Kety, S. S. 1967. Relationship between energy metabolism of the brain and functional activity. See Ref. 102, 39–45

102. Kety, S. S., Evarts, E. V., Williams, H. L., Eds. 1967. *Sleep and Altered States of Consciousness.* Baltimore: Williams & Wilkins. 601 pp.

103. Kharti, I. M., Freis, E. D. 1967. Hemodynamic changes during sleep. *J. Appl. Physiol.* 22:867–73

104. Klein, E. 1963. Étude polygraphique et phylogenique des états de sommeil. *Theses Med. Lyon*

105. Kleitman, N. 1963. *Sleep and Wakefulness.* Univ. Chicago Press. 2nd ed. 552 pp.

106. Kleitman, N. 1967. Phylogenetic, ontogenetic, and environmental determinants in the evolution of sleep-wakefulness cycles. *Res. Nerv. Ment. Dis.* 45:30–38

107. Koella, W. P. 1967. *Sleep: Its Nature and Physiological Organization.* Springfield: Thomas. 199 pp.

108. Koella, W. P. 1969. The central nervous control of sleep. In *The Hypothalamus*, ed. W. Haymaker, E. Anderson, W. J. Nauta, 622–44. Springfield: Thomas

109. Kogan, A. B. 1969. On physiological mechanisms of sleep inhibition irradiation over the cerebral cortex. In *Interdisciplinary Sleep Research. Activitas Nervosa Superior,* 11–2,

ed. T. Radil-Weiss, H. L. Williams, 141–48

110. Kramer, M., Ed. 1969. *Dream Psychology and the New Biology of Dreams*. Springfield: Thomas

111. Lee, M., Kleitman, N. 1923. Studies on the physiology of sleep. II. An attempt to demonstrate functional changes in the nervous system during experimental insomnia. *Am. J. Physiol.* 67:141–52.

112. Lenard, H. G. 1970. Sleep studies in infancy: Facts, concepts, and significance. *Acta Paediat. Scand.* 59:572–81

113. Lester, B. K., Chanes, R. E., Condit, P. T. 1969. A clinical syndrome and EEG sleep changes associated with amino acid deprivation. *Am. J. Psychiat.* 126:185–90

114. Li, C. L. 1959. Synchronization of unit activity in the cerebral cortex. *Science* 129:783–84

115. Lindsley, D. B., Bowden, J., Magoun, H. W. 1949. Effect upon EEG of acute injury to the brain stem activating system. *Electroencephalogr. Clin. Neurophysiol.* 1:475–86

116. Lindsley, D. B., Schreiner, L. H., Knowles, W. B., Magoun, H. B. 1950. Behavioral and EEG changes following chronic brain stem lesions in the cat. *Electroencephalogr. Clin. Neurophysiol.* 2:483–98

117. Lineberry, C. G., Siegel, J. 1971. EEG synchronization, behavioral inhibition and mesencephalic unit effects produced by stimulation of orbital cortex, basal forebrain and caudate nucleus. *Brain Res.* 34:143–61

118. Loomis, A. L., Harvey, E. N., Hobart, G. A. 1937. Cerebral states during sleep as studied by human brain potentials. *J. Exp. Psychol.* 21:127–44

119. Luby, E. D., Gottlieb, J. S. 1966. In *American Handbook of Psychiatry*, ed. S. Arieti, 3:406. New York: Basic Books. 778 pp.

120. Lucas, E., Sterman, M. B., McGinty, D. J. 1969. The salamander EEG: A model of primitive sleep and wakefulness. *Psychophysiology* 6:230

121. Macphail, E. M., Miller, N. E. 1968. Cholinergic brain stimulation in cats: Failure to obtain sleep. *J. Comp. Physiol. Psychol.* 65:499–503

122. Madoz, P., Reinoso-Suárez, F. 1968. Influence of lesions in preoptic region on the states of sleep and wakefulness. *Proc. Int. Congr. Physiol. Sci.* 7:276

123. Magni, F., Moruzzi, G., Rossi, G. F., Zanchetti, A. 1961. EEG arousal following inactivation of the lower brain stem by selective injection of barbiturates into the vertebral circulation. *Arch. Ital. Biol.* 97:33–46

124. Magoun, H. W. 1963. Central neural inhibition. In *Nebraska Symposium on Motivation*, ed. M. R. Jones, 161–93. Lincoln: Univ. Nebraska Press

125. Mandell, M. P., Mandell, A. J., Jacobson, A. 1964. Biochemical and neurophysiological studies of paradoxical sleep. *Recent Advan. Biol. Psychiat.* 7:115–22

126. Manshardt, J., Wurtman, R. J. 1968. Daily rhythm in the noradrenaline content of rat hypothalamus. *Nature* 217:574–75

127. Marchiafava, P., Pompeiano, O. 1964. Pyramidal influences on spinal cord during desynchronized sleep. *Arch. Ital. Biol.* 102:500–29

128. McCleary, R. A. 1966. Response-modulating functions of the limbic system initiation and suppression. In *Progress in Physiological Psychology*, ed. E. Stellar, J. Sprague, 1:210–72. New York: Academic

129. McCormick, J. G. 1969. Relationship of sleep, respiration and anesthesia in the porpoise: a preliminary report. *Proc. Nat. Acad. Sci. USA* 62:679–703

130. McGinty, D. J., Harper, R. M., Fairbanks, M. K. 1972. 5HT-Containing neurons: Unit activity in behaving cats. In *Serotonin and Behavior*, ed. J. Barchas. New York: Academic. In press

131. Mori, A. T. B., Eccleston, D. 1968. The effects of precursor loading in the cerebral metabolism of 5-hydroxyindoles. *J. Neurochem.* 15:1093–1108

132. Monnier, M., Hosli, L. 1965. Humoral transmission of sleep and wakefulness II. Hemodialysis of a sleep inducing humor during stimulation of the thalamic somnogenic area. *Pfluegers Arch. Gesamte Physiol.* 282:60–75

133. Morison, R. S., Dempsey, E. W. 1942. A study of thalamo-cortical

relations. *Am. J. Physiol.* 135:280–92

134. Moruzzi, G. 1960. Synchronizing influences of the brain stem and the inhibitory mechanisms underlying the production of sleep by sensory stimulation. In *Moscow Colloquium on Electroencephalography of Higher Nervous Activity*, ed. H. H. Jasper, G. D. Smirnor 231–56. *Electroencephalogr. Clin. Neurophysiol.* 13:231–56
135. Moruzzi, G. 1964. The historical development of the deafferentation hypothesis of sleep. *Proc. Am. Phil. Soc.* 108:19–28
136. Moruzzi, G. 1964. Reticular influences on the EEG. *Electroencephalogr. Clin. Neurophysiol.* 16:2–17
137. Moruzzi, G. 1965. The functional significance of sleep with particular regard to the brain mechanisms underlying consciousness. In *Brain and Conscious Experience*, ed. J. C. Eccles, 345–88. New York: Springer
138. Moruzzi, G. 1969. Sleep and instinctive behavior. *Arch. Ital. Biol.* 108:175–216
139. Moruzzi, G., Magoun, H. W. 1949. Brain stem reticular formation and activation of the EEG. *Electroencephalogr. Clin. Neurophysiol.* 1:455–73
140. Murata, K., Kameda, K. 1963. The activity of single cortical neurones of unrestrained cats during sleep and wakefulness. *Arch. Ital. Biol.* 101:306–31
141. Murray, E. J. 1965. *Sleep, Dreams and Arousal.* New York: Appleton-Century-Crofts
142. Naquet, R., Denavit, M., Albe-Fessard, D. 1966. Comparison entre le role de subthalamus et celui des différentes structures bulbomésencéphaliques dans le maintien de la vigilance. *Electroencephalogr. Clin. Neurophysiol.* 20:149–64
143. Nauta, W. J. H. 1946. Hypothalamic regulation of sleep in rats: an experimental study. *J. Neurophysiol.* 9:285–316
144. Nauta, W. J. H. 1958. Hippocampal projections and related neural pathways to the midbrain in the cat. *Brain* 81:319–40
145. Ohlmeyer, P., Brilmayer, H., Huellstrung, H. 1944. Periodische vorgaenge im schlaf. *Pfluegers Arch. Gesamte Physiol.* 248:559–60
146. Okuma, T., Hayashi, A., Fujimori, M. 1964. An electrographic study on the changes of experimental seizure discharges induced by local application of convulsants in the neocortex and limbic structures during natural sleep in the cat. *Folia Psychiat. Neurol. Jap.* 18:44–62
147. Oswald, I. 1962. *Sleeping and Waking: Physiology and Psychology.* Amsterdam: Elsevier. 232 pp.
148. Oswald, I. 1968. Drugs and sleep. *Pharmacol. Rev.* 20:273–303
149. Oswald, I. 1969. Sleep and its disorders. In *Handbook of Clinical Neurology*, ed. P. J. Vinken, G. W. Bruyn, 3:80–111. Amsterdam: North-Holland
150. Oswald, I., Ashcroft, G. W., Berger, R. J., Eccleston, D., Evans, J. I., Thacore, V. R. 1966. Some experiments in the chemistry of normal sleep. *Brit. J. Psychiat.* 112:391–99
151. Oswald, I., Taylor, A. M., Triesman, M. 1960. Discriminative responses to stimulation during human sleep. *Brain* 83:440–53
152. Perabo, F. E., Khan, A. V. 1961. Conjoined twins. *Helv. Paediat. Acta* 16:850
153. Peyrethon, J. 1968. *Sommeils et Evolution. Etude Polygraphique des Etats de Sommeil Chez les Poissons et les Reptiles.* Lyon: Tixier
154. Piéron, H. 1913. *Le Problème Physiologique du Sommeil.* Paris: Masson 520 pp.
155. Pisano, M., Rosadini, J., Rossi, G., Zattoni, J. 1966. Relations between threshold of arousal and electroencephalographic patterns during sleep in man. *Physiol. Behav.* 155–58
156. Pletscher, A., Shore, P. A., Brodie, B. B. 1956. Serotonin as a mediator of reserpine action in brain. *J. Pharmacol.* 116:84–89
157. Podvoll, E. M., Goodman, S. J. 1967. Average neural electrical activity and arousal. *Science* 15:223–25
158. Pompeiano, O. 1967. The neurophysiological mechanisms of the postural and motor events during desynchronized sleep. See Ref. 102, 351–423
159. Pompeiano, O. 1970. Mechanisms of sensorimotor integration during sleep. See Ref. 128, 3:3–180

160. Pompeiano, O., Swett, J. E. 1962. EEG and behavioral manifestations of sleep induced by cutaneous nerve stimulation in normal cats. *Arch. Ital. Biol.* 100:311–42
161. Ibid 1963. Actions of graded cutaneous and muscular afferent volleys on brain stem units in the decerebrate decerebellectomized cat. 101:552–83
162. Quay, W. B. 1964. Circadian and estrous rhythms in pineal and brain serotonin. *Progr. Brain Res.* 8:61–63
163. Quay, W. B. 1965. Regional and circadian differences in cerebral serotonin concentrations. *Life Sci.* 4:379
164. Ranson, S. W. 1939. Somnolence caused by hypothalamic lesions in monkeys. *Arch. Neurol. Psychiat.* 41:1–23
165. Ranson, S. W., Ingram, W. R. 1932. Catalepsy caused by lesions between mammillary bodies and third nerve in cat. *Am. J. Physiol.* 101:690–96
166. Ranström, S. 1947. Hypothalamus and sleep regulation: experimental and morphological study. *Acta Pathol. Microbiol. Scand.* 70:1–90
167. Rechtschaffen, A., Cornwell, P., Zimmermann, W. 1965. *Brain temperature variations with paradoxical sleep in the cat.* Presented at 5th ann. meet. Assoc. Psychophysiol. Study Sleep, Washington, D. C.
168. Rechtschaffen, A., Hauri, P., Zeitlin, M. 1966. Auditory awakening thresholds in REM and NREM sleep stages. *Percept. Mot. Skills* 22:927–42
169. Rechtschaffen, A., Kales, A., Eds. 1968. *A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects.* Nat. Inst. Health Publ. 204. Washington, D.C.: GPO. 57 pp.
170. Reis, D. J., Wurtman, R. J. 1968. Diurnal changes in brain noradrenalin. *Life Sci.* 7:91–98
171. Reite, M., Pegram, V. 1967. *Cortical temperature during paradoxical sleep in the monkey.* Presented at 7th ann. meet. Assoc. Psychophysiol. Study Sleep, Santa Monica, Calif.
172. Resnick, O. 1972. The role of biogenic amines in sleep. In *Sleep in the Maturing Nervous System: A Symposium*, ed. C. D. Clemente et al. New York: Academic. In press
173. Rheinberger, M. B., Jasper, H. H. 1937. Electrical activity of the cerebral cortex in the unanesthetized cat. *Am. J. Physiol.* 119:186–96
174. Rhines, R., Magoun, H. W. 1946. Brain stem facilitation of cortical motor response. *J. Neurophysiol.* 9:219–29
175. Roberts, W. W., Berquist, E. H., Robinson, T. C. 1969. Thermoregulatory grooming and sleep-like relaxation induced by local warming of preoptic area and anterior hypothalamus in opossum. *J. Comp. Physiol. Psychol.* 67:182–88
176. Rossi, G. F. 1965. Brain stem facilitating influences on EEG synchronization. Experimental findings and observations in man. *Acta Neurochir.* 13:257–88
177. Rossi, G. F. See Ref. 54, 13–23
178. Rossi, G. F., Minobe, K., Candia, O. 1963. An experimental study of the hypnogenic mechanisms of the brain stem. *Arch. Ital. Biol.* 101:470–92
179. Rossi, G. F., Zirondoli, A. 1955. On the mechanism of the cortical desynchronization elicited by volatile anesthetics. *Electroencephalogr. Clin. Neurophysiol.* 7:383–90
180. Routtenberg, A. 1966. Neural mechanisms of sleep: changing view of reticular formation function. *Psychol. Rev.* 73(6):481–565
181. Saito, Y., Maekawa, K., Takenaka, S., Kasmatsu, A. 1957. Single cortical unit activity during EEG arousal. *Electroencephalogr. Clin. Neurophysiol.* 9:95–98
182. Sauerland, E. K., Nakamura, Y., Clemente, C. D. 1967. The role of the lower brain stem in cortically induced inhibition of somatic reflexes in the cat. *Brain Res.* 6:164–80
183. Schaeppi, U., Koella, W. P. 1964. Adrenergic innervation of cat iris sphincter. *Am. J. Physiol.* 207:273–78
184. Schaff, G., Marbach, G., Vogt, J. J. 1962. Concomitant variations in spontaneous motility, the cardiac frequency and respiratory frequency in the course of sleep under the influence of various stages of fatigue. *C. R. Soc. Biol.* 156:1517–22

185. Scheibel, M. E., Scheibel, A. B. 1966. The organization of the nucleus reticularis thalami: A Golgi study. *Brain Res.* 1:43–62
186. Ibid 1967. Structural organization of nonspecific thalamic nuclei and their projection toward cortex. 6:60–94
187. Schnedorf, J. G., Ivy, A. C. 1939. An examination of the hypnotoxin theory of sleep. *Am. J. Physiol.* 125:491–505
188. Shute, C. C., Lewis, P. R. 1966. Cholinergic and monoaminergic pathways in the hypothalamus. *Brit. Med. Bull.* 22:221–26
189. Snyder, F. 1965. The organismic state associated with dreaming. In *Psychoanalysis and Current Biological Thought*, ed. N. S. Greenfield, W. C. Lewis, 275–315. Madison: Univ. Wisconsin
190. Snyder, F. 1969. Sleep disturbance in relation to acute psychosis. See Ref. 96, 170–82
191. Snyder, F. 1971. The physiology of dreaming. *Behav. Sci.* 16:31–44
192. Snyder, F., Hobson, J. A., Morrison, D. F., Goldfrank, F. 1964. Changes in respiration, heart rate and systolic blood pressure in relation to electroencephalographic patterns of human sleep. *J. Appl. Physiol.* 19:417–22
193. Sterman, M. B., Clemente, C. D. 1968. Basal forebrain structures and sleep. *Acta Neurol. Latinoam.* 14:228–44
194. Sterman, M. B., Clemente, C. D. 1972. Forebrain mechanisms and the onset of sleep. Proc. NATO Advan. Stud. Inst.: *Basic Sleep Mechanisms*, ed. O. Petre-Quadens, J. Schlag. New York: Academic. In press
195. Sterman, M. B., Hoppenbrouwers, T. 1971. The development of sleep-waking and rest-activity patterns from fetus to adult in man. In *Brain Development and Behavior*, ed. M. B. Sterman, D. J. McGinty, A. M. Adinolfi, 230–307. New York: Academic
196. Tart, C. T. 1967. Patterns of basal skin resistance during sleep. *Psychophysiology* 4:35–39
197. Tauber, E. S., Roffwarg, H. P., Weitzman, E. D. 1966. Eye movements and electrographic activity during sleep in the diurnal lizards, *Chamelea Jacksoni* and *C. Melleri. Nature* 212:1612–13
198. Thompson, R. F. 1967. *Foundations of Physiological Psychology.* New York: Harper and Row. 688 pp.
199. Torda, C. 1969. Biochemical and bioelectrical processes related to sleep, paradoxical sleep and arousal. *Psychol. Rep.* 24:807–24
200. Velasco, M., Lindsley, D. B. 1965. Role of orbital cortex in regulation of thalamocortical electrical activity. *Science* 149:1375–77
201. Villablanca, J. 1962. Electroencephalogram in the permanently isolated forebrain of the cat. *Science* 138:44–46
202. Villablanca, J. 1966. Behavioral and polygraphic study of 'sleep' and 'wakefulness' in chronic decerebrate cats. *Electroencephalogr. Clin. Neurophysiol.* 21:562–77
203. Webb, W. B., Ed. 1968. *Sleep: An Experimental Approach.* New York: McMillan. 250 pp.
204. Webb, W. B. 1969. Partial and differential sleep deprivation. See Ref. 96, 221–31
205. Webb, W. B. 1971. Sleep behavior as as a biorhythm. In *Biological Rhythms and Human Performance*, ed. P. Coloquohon, 149–77. London: Academic
206. Weinberger, N. M., Velasco, M., Lindsley, D. B. 1965. Differential effects of reinforced and nonreinforced stimuli upon electrocortical recruiting responses. *Psychon. Sci.* 2:129–30
207. Weiss, T., Roldan, E. 1964. Comparative study of sleep cycles in rodents. *Experientia* 20:280–81
208. Weitzman, E. D. 1969. Biogenic amines and sleep stage activity. See Ref. 96, 232–44
209. Williams, H. L. 1971. The new biology of sleep. *J. Psychiat. Res.* 8:445–78
210. Williams, H. L., Granda, A. M., Jones, R. C., Lubin, A., Armington, J. C. 1962. EEG frequency and finger pulse volume as predictors of reaction time during sleep loss. *Electroencephalogr. Clin. Neurophysiol.* 14:64–70
211. Williams, H. L., Hammack, J. R., Daly, R. L., Dement, W. C., Lubin, A. 1964. Responses to auditory stimulation, sleep loss and the EEG stages of sleep. *Electroencephalogr. Clin. Neurophysiol.* 16:269–79
212. Williams, H. L., Morlock, H. C.,

Morlock, J. V. 1966. Instrumental behavior during sleep. *Psychophysiology* 2:208-15

213. Williams, H. L., Williams, C. L. 1966. Nocturnal EEG profiles and performance. *Psychophysiology* 3:164-75

214. Wolstenholme, G. E. W., O'Connor, M., Eds. 1961. *CIBA Foundation Symposium on the Nature of Sleep.* Boston: Little & Brown. 416 pp.

215. Wurtman, R. J., Axelrod, J., Sedvall, G., Moore, R. Y. 1967. Photic and neural control of the 24-hour norepinephrine rhythm in the rat pineal gland. *J. Pharmacol. Exp. Ther.* 157:487-92

216. Wyatt, R. J., Chase, T. N., Scott, J., Snyder, F., Engelman, K. 1970. Effect of L-dopa on the sleep of man. *Nature* 228:999-1000

217. Wyatt, R. J., Engelman, K., Kupfer, D. J., Fram, D. H., Sjoerdsma, A., Snyder, F. 1970. Effects of L-tryptophan (a natural sedative) on human sleep. *Lancet* 2:842-46

218. Wyatt, R. J., Engelman, K., Sjoerdsma, A., Snyder, F. 1970. 5-hydroxytryptophan (5-HTP) effects on the sleep of man. *Psychophysiology* 7:318

219. Yamaguchi, N., Ling, G. M., Marczynski, T. J. 1964. Recruiting responses observed during wakefulness and sleep in unanesthetized chronic cats. *Electroencephalogr. Clin. Neurophysiol.* 17:246-54

220. Zarcone, V., Dement, W. C. 1969. Sleep disturbances in schizophrenia. See Ref. 96, 192-99

221. Zung, W. W. K., Wilson, W. P. 1961. Response to auditory stimulation during sleep. *Arch. Gen. Psychiat.* 4:548-52

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INTERPERSONAL ATTRACTION

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The expansion of interest in attraction research is best shown by the positively accelerating curve of references in psychological and sociological journals. From the widely scattered correlational studies in the first half of this century to the somewhat more numerous experimental investigations of the 1950s and early 1960s to the present deluge, attraction research shows no sign as yet of reaching asymptote. In preparing the first chapter on this topic for the *Annual Review of Psychology*, it became clear that a simple listing of only the directly relevant references would easily consume the total page allotment. In order to avoid that very tempting alternative, we have chosen as a primary focus the experimental work of the past 10 to 15 years which deals specifically with attraction. One unfortunate result of such selectivity is the total omission or barest mention of several closely related areas of research.

To obtain a more extensive view of the field, the reader is advised to examine recent reviews of areas such as impression formation (4), person perception (145), social perception (146), sociometric choice (105), ingratiation (84), marital success (73, 100), and social attraction in animals (96). More general reviews of attraction research have been provided by Aronson (6), Berscheid & Walster (13), Byrne (18, 19), and Taylor (147). In addition, two collections of original theoretical presentations edited by Huston (80) and by Murstein (118) constitute extremely useful and wide-ranging summaries of current work. A possible sign of the intensity of current interest is the proliferation of theoretical criticisms directed at one or more aspects of the work on attraction (8, 88, 101, 119, 158), often followed by a reply, rejoinder, or counterattack (20, 26, 31).

Attraction research may be conceptualized as an effort to establish and explain the relationship between certain classes of antecedent events and certain classes of consequent events. The present review will be organized around four topical areas: (*a*) the types of responses defined as indicators of attraction; (*b*) the stimulus variables identified as antecedents of attraction; (*c*) the consequences of attraction (i.e. behaviors mediated by attraction); and (*d*) theories which attempt to provide a general conceptual framework for the attraction process.

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MEASUREMENT OF ATTRACTION RESPONSES

Interpersonal attraction is a construct referring primarily to an individual's affective evaluation of another individual. At the operational level, attraction has been measured in many different ways by numerous investigators and sometimes in many ways even by the same investigator.

Verbal measures.—The most widely used measurement technique relies on a simple scaling of verbal responses expressed in terms of ratings or judgments of the target person on one or more dimensions. On social distance measures, respondents indicate their willingness to engage in activities of varying degrees of social intimacy with a target person. These instruments are described by their proponents (142, 151) as more personally involving than verbal rating scales which call for statements of evaluation and general liking.

With sociometric techniques, subjects are asked to indicate their choices of individuals as friends, leaders, group members, and work partners. The historically important role of this measurement technique, as well as an analysis of its advantages and disadvantages, has been provided by Lindzey & Byrne (105).

When target persons are rated on bipolar scales of positive and negative adjective trait combinations, interpersonal evaluations are indicated by summed ratings across many scales or a series of ratings on individual scales (62, 83, 97, 98, 122). Still other verbal indices utilized as measures of attraction include heterosexual dating preferences (12, 116, 153), roommate preferences (123, 139), the positiveness of adjectives generated to describe targets (3), affiliative choices (160), interview assessments of likability (7), as well as somewhat more elaborate measures of love (131) and friendship (157).

The single measure of attraction used most frequently and about which the most extensive empirical data are available is the Interpersonal Judgment Scale (19). This instrument is a six-item Likert-type rating scale on which subjects evaluate target persons on seven-point dimensions of intelligence, knowledge of current events, morality, adjustment, likability, and desirability as a work partner. Scores on the latter two sociometrically oriented items are summed to yield an index of attraction with a split-half reliability of .85. This attraction measure has been found to be related to a number of other measures designed to assess attraction such as: social distance scales; social choice; ratings of desirability as a date, sexual partner, and spouse; voluntary physical proximity; eye contact; the affective dimension of the semantic differential scale; voting choices; and a number of additional verbal and nonverbal behaviors (19).

Kiesler & Goldberg (90) factor analyzed a variety of response measures typically utilized as measures of attraction and extracted two factors. The first, characterized as primarily socioemotional, included such variables as liking, desirability of the target's inclusion in social clubs and parties, seating choices, and lunching together. The second factor included variables such as voting for, admiration and respect for, and seeking the opinion of the target. The latter factor was conceptualized in terms of task orientation or respect for the target. In view of the variety of verbal measures of attraction which have been devised, such attempts to examine the generality of any given index or combination of indices constitutes a valuable contribution.

Some investigators (6, 85, 86, 136) have questioned the use of measures of attraction which rely upon verbal assessments. There is concern that verbal measures are highly susceptible to demand and bias effects due to the ease with which the response is recorded and the possibility that subjects attempt to hide their "true" feelings. Assuming that true feelings exist, that subjects are aware of them, and that subjects would rather reveal their feelings than be second-guessed by a machine, Jones & Sigall (86) propose the use of the bogus pipeline technique as a sensitive index of attraction. Briefly, the technique involves convincing subjects that the machine functions as a "pipeline to the soul" and then requiring them to estimate the meter readings which the machine is purportedly providing to the experimenter. Preliminary findings suggest that attraction as measured under bogus pipeline conditions differs from attraction as measured by the usual verbal response scales (85, 136). The suggestion that the bogus pipeline assesses "true" feelings is, however, questionable unless one views attraction as some real entity instead of simply as a useful construct.

Nonverbal measures.—Several nonverbal behaviors have also been utilized as measures of attraction. Among the proposed indicants of attraction are visual contact (49, 51, 53); physical proximity (21, 29); bodily postures such as forward and backward lean, relaxation, and arm position (112); placement of silhouette figures in hypothetical social situations (102, 103, 106); and physiological responses (44, 55).

Among the few attempts to study the interrelationships among these nonverbal indices are studies of bodily and posture variations (112) and of the relationship between visual contact and seating proximity (65). Because such measures are related to verbal attraction measures somewhat weakly and often in a rather complex fashion, these behavioral measures cannot be considered as interchangeable with verbal assessments. No one has maintained that attraction is a single-faceted construct or that any existing measure is inherently superior to all others. It does appear, however, that the unsystematic proliferation of attraction indices without consideration of their comparability has not facilitated the creation of a cumulative set of meaningfully interrelated empirical relationships.

STIMULI ELICITING ATTRACTION RESPONSES

Attraction has been found to be a function of the relationship between the target's characteristics and the respondent's own characteristics, specific characteristics or behaviors of the target individual, stimulus conditions not directly attributable to the target, and to personality characteristics of the respondent.

Relationship between characteristics of target and respondent.—The similarity or dissimilarity of the attitudes of the target and the respondent has received the greatest amount of empirical attention in research to date. The reason for this interest seems to lie in the apparent ubiquity of the similarity-attraction relationship, the reliability with which the effect is obtained, and the ease with which such variables can be manipulated experimentally. Several decades of correlational research on this topic culminated in Newcomb's (120) partially controlled field study in which previously unacquainted students were given rent-free accomodations in a cooperative housing unit in return for their participation as research subjects. The attraction patterns which developed within the group were found to be positively related to preacquaintance similarity across a variety of attitudinal issues and, more strongly, to agreement in assessing other house members. These findings were later replicated (46).

Attraction, as assessed by the Interpersonal Judgment Scale, has repeatedly been found to vary as a positive linear function of the proportion of shared similar attitudes or opinions between subject and target (19). Typically, subject attitudes are assessed in a preliminary session and the simulated attitudes of an anonymous target are presented to the subject at a later time. The relationship between proportion of similar attitudes and attraction has been obtained when the attitudinal information concerning the target is transmitted via mimeographed attitude scales, tape recordings, movies (22), closed-circuit television (74), face-to-face interactions involving a confederate (8, 31) and when "real life" individuals express their own attitudes in face-to-face interactions (17).

Detailed analyses of the attitude-attraction relationship have demonstrated that the importance of specific attitudinal topics influences attraction responses only when agreement by a target is at an intermediate level between .00 and 1.00, the attitudinal items are heterogeneous in their importance, and when items of differential importance systematically are associated with similarity-dissimilarity. When these conditions prevail, agreement on important issues exerts a relative effect on attraction approximately three times that of unimportant issues (38). Other analytic research indicates that attraction is influenced by seemingly small discrepancies of attitude position in addition to general agreement or disagreement (25) and by structural similarity, the pattern of interrelationships of attitudes (148). Such analyses have made it possible to express the attitude-attraction function in relatively precise mathematical terms.

The basic similarity-attraction relationship is found to be quite general across a variety of subject populations. The linear function has been found to hold among children down through the fourth grade level (32); among low socioeconomic status individuals such as Job Corps Trainees and among alcoholic and schizophrenic hospital patients (35); among Japanese, Indian, and Mexican students (30); and among senior citizens (66).

Three basic research designs have been utilized to study the influence of personality similarity on attraction. In one approach, existing attraction pairs such as friends, fiances, or spouses are selected and then assessed with respect to one or more personality variables; the scores of the series of pairs are correlated. In a second approach, the personality measure or measures are obtained, and then previously unacquainted subjects are selected on the basis of their test scores and placed in an interactive situation, followed by an assessment of their attraction. Unlike analogous field studies and interactive studies with attitudes, inconsistency has characterized the findings obtained when either of these designs is used. For example, data have been reported supporting the notion that similarity of personality characteristics fosters attraction (9, 82, 113). Other studies have indicated that complementarity of personality is associated with attraction (156). Still other findings suggest that both similarity and complementarity of personality lead to attraction (89). Finally, no relationship between personality and attraction has been obtained in a number of studies (75, 76). There are two basic flaws in each of the two designs which make it impossible to answer the prototypic question concerning the effect of personality similarity on attraction (36). In neither design is there control of the additional stimulus determinants of attraction beyond the small array of personality characteristics under study, and the relationship between the personality-relevant behavior of the subject and that of the target is unknown or nonexistent. In research utilizing a third design, these two problems have been eliminated. Here the subject's personality-relevant behavior consists of his responses to the instrument used to assess personality characteristics, and he is subsequently exposed to the responses of the target on the same instrument with other stimulus elements controlled experimentally. With this design it has been shown that attraction is positively related to similarity along such dimensions as self-concept (57, 58), repression-sensitization (33, 36), Marlowe-Crowne need for approval (54, 123), self-esteem (72), ability (128), and dominance-submissiveness (126). It has also been possible with this design to isolate a few variables on which the effect of similarity varies in part as a function of the subject's standing on the personality dimension in question (71, 72, 127), specifically introversion-extraversion, self-esteem, and internal-external control.

In addition to studies of attitudes and personality characteristics, similarity along a number of other dimensions has been found to be positively related to attraction. Examples include economic status (27), relatively simple behavioral acts (79), task performance (134, 159), emotional states (160), and perceived social desirability of self and target (12, 116). It is clear that, with respect to many variables, similarity tends to be preferred to dissimilarity, at least in the kind of experimental situations normally employed.

Characteristics or behaviors of the target individual.—Attraction has been shown to be positively related to the physical attractiveness of targets in several investigations. In response to photographic stimuli, both male and female subjects indicated greater attraction toward physically attractive same and opposite-sex targets than toward unattractive ones (39). In later research, more extreme differences in physical attractiveness and only opposite-sex targets were used; it was reported that attractiveness effects on the work partner scale and measures of the target's desirability as a dating and marriage partner are stronger for males than female subjects (144). Physical attractiveness seems to play an especially strong role in the dating situation. In studies of a prospective date whose photograph was available (116), actual partners in a computer dating experiment (29), and actual dates at a computer dance (155), physical attractiveness was found to be a strong and consistent determinant of interpersonal attraction.

Interest in the effects of racial characteristics on attraction has been intensified by the race-versus-belief controversy initiated by Milton Rokeach and Harry Triandis. The issue was whether racial membership (black versus white) or attitudinal similarity-dissimilarity constitutes the more powerful variable in the determination of interracial attraction. Rokeach, Smith, & Evans (130) reported that the effects of racial membership were largely outweighed by attitudinal similarity-dissimilarity in the determination of friendship choices. Triandis (150) utilized a social distance measure and concluded that race has a greater effect than beliefs; it was later suggested that the results obtained are largely dependent on the response variables in that different responses are influenced by different stimuli (151). The issue nevertheless remains alive and well in social psychology, and subsequent investigators have noted several reasons why the findings have differed from laboratory to laboratory (70, 81, 142), primarily revolving around differences in stimulus presentations and in the assessment of the dependent variable. Byrne & Ervin (28) pointed out that the effects of race and belief are relative and vary as a function of the views attributed to a black target person and to the prejudice level of the white subject. For example, there is no effect of Negro racial membership on the attraction responses of low prejudice subjects, while for high prejudice subjects such information exerts a negative influence on attraction approximately 11 times that of the positive effect of a single attitudinal agreement. With a sufficient number of attitudinal agreements, it is thus possible to mitigate or even nullify the prejudice-racial membership interaction; conversely, with a small amount of attitudinal agreement, the effect of race will be strongly evident for subjects high in prejudice.

In addition to physical attractiveness and racial membership, the influence of several other target characteristics on attraction has received some attention. For example, both males and females respond more positively to targets who maintain eye contact with them, and they prefer opposite-sex individuals with dilated pupils to those with nondilated pupils (141). In another study, a gazing interviewer was rated more positively than a nongazing interviewer when the interview content was favorable, while the reverse relationship was obtained when the interview content was unfavorable (50). Males were found to rate photographically depicted males more positively when the irises were light than when they were dark (87). Other nonverbal characteristics and behaviors of targets such as standing posture, arm position, bodily relaxation (112), smiling (77), and vocal attractiveness (97) also have been found to influence interpersonal responses. Presumably, such attraction influences are the result of the subject's past experiences with and expectancies concerning the consequents of these stimulus characteristics of the target.

While the target person's prestige has been found to have a positive effect on attraction (15), prestige effects are negligible when the subject is also provided with information about the stranger's attitudes (34). In other studies, attraction has been found to be positively related to the scholastic and intellectual competence of the target (63, 125). Novak & Lerner (122) were able to demonstrate that the similarity-attraction relationship is less when the target is described as emotionally maladjusted, though this finding has been shown to be a function of the type and quantity of stimulus information available to the subject (37).

The target's evaluations of the subject's personal attributes are found to have a very strong effect on attraction. Positive evaluation elicits much more positive responses than negative evaluation when received by the subject in paper and pencil form (40, 61), in face-to-face situations (8, 31), and when they are overheard by the subject (7). Cognitive consistency theories predict that subjects will respond positively to the favorable evaluations of others only if the subjects positively evaluate themselves. This congruency hypothesis was tested by Deutsch & Solomon (48) in a situation in which the subjects were led to believe that their actual task performance was poor or good. Their performance was subsequently evaluated either positively or negatively by a confederate. When task performance was actually good, positive evaluators were liked more than negative evaluators, but no differences in liking for the two kinds of evaluators were found when task performance was poor. Support for the hypothesis was somewhat weak in that negative evaluators were not actually liked more than positive evaluators in the poor performance condition. In attempts to replicate these results, it has been found that positive evaluators are liked better than negative evaluators in both conditions (137). Some support for the hypothesis may be found, however, in studies involving role-playing strategies (14, 111).

Stimulus conditions not directly attributable to the target.—The influence of experimentally induced emotions and drives on attraction has been investigated primarily in research testing hypotheses derived from a reinforcement-affect model. Griffitt (60) manipulated feelings of comfort-discomfort through variations in ambient temperature and found attraction toward targets to be more negative under hot than under normal temperature conditions. In a second study (67) the temperature effect was replicated, and it was additionally found that attraction responses were more negative under extremely crowded than under less crowded conditions. The greater the reported degree of discomfort and feelings of unpleasantness, the more negative the response to the target, thus supporting the hypothesis that attraction is mediated by affect. Further support is provided by an experiment in which moods of elation or depression were induced by means of motion pictures, followed by an attitude-attraction task (56). Depressed subjects reponded more negatively to targets than did elated subjects.

The role of sexual arousal in the determination of attraction responses has been the subject of recent experiments (68). Sexual arousal was manipulated by exposing subjects to either a series of erotic literary passages or to a series of nonerotic control passages. Immediately afterward, attraction was assessed toward same or opposite sex targets holding similar or dissimilar attitudes. For male subjects, attraction was not influenced by sexual arousal nor by the sex of the target. Females responded more positively to male than to female targets when sexually aroused, as well as more positively to male targets when aroused than when not aroused. In subsequent work (65), sexually aroused males and females were found to look more frequently at opposite sex targets than did control subjects. Sexual arousal has also been shown to influence male's perceptions of female targets (143).

Another manipulation of interest is that of temporarily induced changes in self-esteem and its effect on attraction (83, 152). Subjects whose self-esteem was lowered (by faked personality test feedback) responded more positively to an accepting target than did subjects whose self-esteem was raised. Also, subjects with raised self-esteem responded more positively to targets whose evaluations of them were ambiguous than did lowered self-esteem subjects.

It has been proposed by Byrne & Clore (23) that the attitude-attraction relationship is mediated by effectance motivation which refers to a learned drive to be logical, to make a correct report of one's environment, and to form and maintain valid attitudes and opinions concerning the relatively ambiguous social environment. Agreement elicits positive responses through consensual validation of opinions, while disagreement elicits negative responses through consensual invalidation of one's attitudes and opinions. Assuming that effectance motivation is aroused by exposure to unpredictable environmental conditions, the investigators presented subjects with either a specially prepared film composed of meaningless visual and auditory sequences or with a predictable film concerning life in Morocco. All subjects afterward responded to attitudinally similar or dissimilar targets. While it was expected that the similarity-attraction relationship would be stronger as effectance level increased, it was found that similarity and attraction were most strongly related for moderately aroused subjects. It was suggested that the high arousal subjects were so confused and disoriented that attention to target information was attenuated, thus leading to less polarized attraction responses. Later work has extended some of these findings (135).

Darley & Berscheid (47) investigated the effects of anticipation of future contact with targets on attraction. An ambiguously described target was rated more favorably when future contact was anticipated than when no contact was anticipated. Additional findings indicated that anticipated contact also leads to more positive evaluations of negatively described targets (11). Others (2, 99) have shown that the effects of anticipated contact with targets on attraction depend on the presumed positiveness or negativeness of the pending interaction.

Personality characteristics of the respondent.—The search for relatively stable personality variables which reliably influence attraction responses has occupied the efforts of a large number of investigators, most frequently in the context of attitude-attraction studies. The fruits born of these labors have more often been sour than sweet, however, for there seem to be a great many personality variables which are simply unrelated to responses in the attraction situation. For example, individual differences in authoritarianism, dogmatism, repression-sensitization, self-ideal discrepancy, and cognitive complexity have been found to have no influence on the basic similarity-attraction relationship (19).

With respect to other personality variables, there is some inconsistency in the findings. For example, the reported effects of Marlowe-Crowne need for approval have included a positive relationship with attraction responses, a positive relationship only when there is expectation of meeting the target person, no relationship with attraction, and opposite effects for male and female subjects (19, 77). Additional personality variables which have produced a mixed bag of effects include stability of self-esteem (5, 72, 152), intolerance for ambiguity (45), and need for affiliation (19). Various anxiety measures have also been found to show no consistent relationships with attraction, though there is evidence that social-evaluative anxiety may prove to be a useful moderator variable (138).

CONSEQUENCES OF ATTRACTION

While the preceding discussion has focused on attraction as a dependent variable, the present section consists of a summary of findings concerning attraction as a mediator of other behaviors. In this context, attraction may be viewed as an independent variable associated with various consequent behaviors. Lott & Lott (110) have provided an excellent review of the consequences literature, and their outline will be followed here.

Approach and avoidance responses.—In general, individuals will move (physically, verbally, or symbolically) toward those they like and away from those they dislike. With visual behavior, for example, liked persons are looked at more, are seen as larger, are more easily recognized, and are dominant in a binocular rivalry task when compared with disliked persons. In addition, as noted earlier, subjects have been found to maintain closer seated and standing proximity to liked than disliked others in both symbolic and actual interaction situations. Verbal approach and avoidance tendencies have been studied with the majority of findings indicating that liked individuals are more often the targets of nonpersuasive communications than are disliked targets and that communication accuracy is positively related to interpersonal attraction (110).

Evaluative and descriptive responses.—Liked persons are generally evaluated more positively than disliked persons across a variety of dimensions including intelligence, knowledge of current events. morality, adjustment (19), affective dimensions of the semantic differential (62), and various adjective-trait characteristics scaled in terms of likability (110). Defendants in simulated jury studies are judged more harshly in terms of degree of guilt, length of prison sentence, and degree of punishment to be received when disliked than when liked (64, 95, 115). In one experiment (139), identical performances on a verbal learning task were evaluated more positively when the performer was liked than when disliked.

In addition, attraction is positively related to the degree of similarity attributed to the target, to the degree to which subjects feel that they are liked by the target, to the amount of detail with which targets are described (110), and to the anticipated positiveness of contact with the target (59).

Conformity, modeling, and acquiescence.—There is considerable empirical and popular support for the notion that influence over an individual varies positively with the degree to which the influence agent is liked. For example, conformity to group opinions and judgments is found to be positively related to liking for the group when compliance is not forced and when subjects are not committed to continue in the group (91). High attraction to models has been found to facilitate the imitation of preferences in buying paint, going deep-sea diving, choosing nonsense syllables, and selecting games (110). Imitation of betting strategy was facilitated by high attraction to a competent model but inhibited by high attraction to an incompetent model (10). In studies of imitation in children (e.g. 114), nurturant (liked) models are more frequently imitated than non-nurturant (disliked) models.

The influence of attraction on behavior in the prisoner's dilemma game has been the subject of a series of studies by Tedeschi and his associates. Subjects have been found to make more cooperative and accomodative choices when their partner is liked than when disliked (132, 133) and tend to comply more to the threats of a credible liked partner than to a credible disliked partner (16).

Still other research suggests that patient improvement in psychotherapy is faciliated by high attraction between patient and therapist (42) and that helping behavior is facilitated if the person in need of help is liked as opposed to disliked (92).

Learning.—Attraction has been shown to affect the learning and performance of several behaviors (110). Experimenters who are liked are generally more effective in producing high rates of conditioning, task performance, and persistence than are disliked experimenters. The mere presence of liked persons has been shown to facilitate the learning of relatively simple verbal material but to interfere with learning when the task is moderately difficult. It has also been found that photographs of liked and disliked peers can serve, respectively, as positive and negative reinforcers in a discrimination learning task, and that paired-associates learning is facilitated when the names of liked as opposed to disliked persons are paired with nonsense syllables (110).

On the basis of such investigations of the consequents of attraction, Lott & Lott suggest that the application of these findings is now feasible in areas such as communication, racial tolerance, and academic learning.

THEORIES OF INTERPERSONAL ATTRACTION

Psychological theories, insofar as they represent abstract constructions and conceptualizations of diverse behavioral phenomena, probably are best described by the architects of the theories themselves. Second-hand descriptive accounts of theories often turn out to be primarily evaluative perorations and to involve the endless construction and destruction of straw men which often bear only passing resemblance to the positions of the original theorists. With such potential pitfalls well in mind, we will provide brief summary descriptions of the major theoretical conceptualizations of interpersonal attraction in conjunction with a few representative findings relevant to each position. The two primary conceptualizations of attraction phenomena may be roughly categorized as cognitive and reinforcement theories.

Cognitive theories.—Cognitive theorists (e.g. 69, 121) tend to emphasize the relational characteristics among elements of a closed triadic system comprised of at least two individuals and an object of communication (something or someone). The basic unit of such theories is the cognition which is "any knowledge, opinion, or belief about the environment, about oneself, or about one's behavior that a person might hold" (13, p. 14). Certain configurations among the cognitions within a triadic system are viewed as psychologically more pleasant than other types of cognitive relationships, and individuals are hypothesized to strive actively to maintain pleasant configurations and to avoid unpleasant ones. From the point of view of Newcomb's (121) modification of Heider's (69) balance theory, the most pleasant relationships consist of those which are positively balanced; imbalanced relationships are experienced as most negative, and nonbalanced configurations are evaluated relatively indifferently. Utilizing Newcomb's (121) symbols, positively balanced situations occur when a person (P) positively evaluates another person (O) and both P and O agree concerning their evaluation (positive or negative) of a third object (X). A state of psychological imbalance occurs when the P to O (P/O) relationship is positive but the P/X and O/X evaluations are in disagreement. Nonbalance is said to occur in any situation in which the P/O relationship is negative. Associated with the three states of balance, imbalance, and nonbalance are "experiences of preferring to accept a set of cognitive elements as they are, to modify it, or to be relatively indifferent as between its acceptance or its modification" (121, p. 32). Most relevant with respect to interpersonal attraction is the P/O relationship which is seen as primarily determined by P/X and O/X similarity and dissimilarity. P/O attraction will be most positive when P and O are in agreement concerning X and most negative when P perceives that he and O disagree concerning X. Since nonbalance is somewhat preferred over imbalance, a positive P/O relationship will tend to become negative as P perceives disagreement with O concerning X. It should be noted that the stress of imbalance may also be reduced by alterations of P/X, persuasive attempts to alter O/X, or misperceptions of O/X.

The attitudinal similarity studies reviewed previously are most relevant to cognitive balance interpretations of attraction. The obtained positive relationship between agreement and attraction is clearly consistent with balance predictions.

In addition, when X consists of P's self-concept, positive O/X evaluations should lead to positive P/O response, assuming that P likes himself. As noted above, there are numerous findings which support this notion. Other data, in the form of ratings of the pleasantness of hypothetical relationships, generally support the balance theory predictions concerning the affective consequents of the three kinds of balance.

While the Heider-Newcomb formulation has received the greatest amount of attention in attraction research, other cognitive theories similarly propose that inconsistent cognitions produce unpleasant states of dissonance (52) or incongruity (124), the reduction of which may involve alterations in evaluations of a target person. A detailed account of such theories is provided in a recent volume (1).

Reinforcement theories.—In contrast to cognitive theorists, reinforcement theorists (e.g. 24, 43, 109, 140) tend to focus on stimuli and responses as the basic units comprising interpersonal interactions, on the positive and negative properties of the relevant stimuli, and on the utility of borrowing concepts from learning theory to apply to the attraction situation.

Hull-Spence associational learning theory concepts are utilized in the Lotts' formulation of attraction theory. The theory rests on four basic assumptions: (*a*) persons represent discriminable stimuli; (*b*) reinforcement results in an overt or covert goal response (R_g or r_g); (*c*) the goal response becomes conditioned to all discriminable stimuli present at the time of reinforcement; and (*d*) when such a goal response is conditioned to a person, that person in later situations will evoke R_g or r_g–s_g.

The Byrne & Clore (24, 43) model is similar to that of the Lotts but is less strongly committed to any specific theory of learning. From an associational standpoint, it is proposed that any stimulus with reinforcement properties functions as an unconditioned stimulus for an implicit affective response which is assumed to fall along a subjective continuum that is characterized as pleasant-unpleasant. The reinforcement properties of stimuli are defined independently of the attraction situation in terms of the empirical law of effect: the capacity to alter response probability. Any discriminable stimulus, including a person, which is temporally associated with the unconditioned stimulus can become a conditioned stimulus capable of evoking the implicit affective response. This implicit response is hypothesized to mediate evaluative responses to the conditioned stimulus. Evaluative responses include verbal assessments of the conditioned stimulus, various types of choice behavior, and approach and avoidance reactions. The attraction formulation of Lott & Lott (109) and of Byrne & Clore (24) have much in common with Staats' (140) theoretical system which was developed in the context of a quite different data base.

From studies of the precise manner in which stimuli combine to determine attraction, an empirically derived "law of attraction" has been presented (19) as

$$A_x = m\left[\frac{\Sigma(PR_x \times M)}{\Sigma(PR_x \times M) + \Sigma(NR_x \times M)}\right] + k$$

or attraction toward X is a positive linear function of the sum of the weighted positive reinforcements (number times magnitude) associated with X divided by the total number of weighted positive and negative reinforcements associated with X.

A great deal of research has been stimulated by the above reinforcement formulations; representative examples include Byrne, Young & Griffitt (41); Lamberth (94); Lott et al (108); Reitz, Douey & Mason (129); and Lombardo, Weiss & Stich (107). In general, data falling within the boundary conditions of the theories consist of any stimulus-response relationship in which stimulus conditions may be conceptualized in terms of affective meaning and in which response variables are primarily evaluative in nature. It should be noted that reinforcement and cognitive theories do not constitute incompatible and mutually exclusive explanatory systems concerning attraction. In fact, many of the empirical relationships previously considered are interpretable in either cognitive or reinforcement terms (37). In addition, cognitive theories have generated hypotheses (e.g. assumed similarity, misperception, and persuasion) which would most likely not have been suggested by a learning model. Similarly, hypotheses generated by reinforcement theory (e.g. attitudes as reinforcing stimuli, the role of affective states, the effect of delayed reward on attraction) do not appear to be the natural offspring of a balance theory. Equally utilitarian theoretical formulations need not be cast as embattled competitors.

Other theories.—Additional formulations have been proposed to deal with various aspects of attraction, usually focusing on dyadic interactions. Examples are exchange theory (78, 149), gain-loss theory (7), and theories of marital choice (104, 117), romantic love (131, 154), and friendship (157). In addition, Anderson's information integration theory, while not conceptualizing stimulus information in terms of rewards or reinforcements, shares much in common with the law of attraction in terms of its focus on the manner in which units of stimulus information combine to affect judgments of targets. The Anderson model is basically a weighted averaging model of target judgment and is viewed as encompassing a variety of judgment phenomena (4).

COMMENT

Cumulative scientific progress is greatest when investigators practice what Kuhn (93) describes as "normal science," which becomes possible following the acquisition of a paradigm. A scientific paradigm is characterized by a specific body of research consisting of agreed-upon procedures, operations, measuring devices, empirical laws, and a common theoretical superstructure. Such agreement, at least among a small group of individuals interested in the same phenomena, makes it possible to accumulate knowledge through attempts to increase the precision, reliability, and scope with which the facts are known and through continual formulation and modification of theoretical propositions put forward to account for the data. At the present time, research on interpersonal attraction may be seen as comprised of a small number of relatively independent mini-paradigms plus a number of nonparadigmatic approaches to data collection. If research in this area continues to proliferate at its present astonishing rate, it will be of interest to document the development of the study of attraction as it moves into the realm of a true paradigmatic science.

LITERATURE CITED

1. Abelson, R. P. et al, Eds. 1968. *Theories of Cognitive Consistency: A Sourcebook.* Chicago: Rand McNally
2. Alderman, D. 1969. Effects of anticipating future interaction on the preference for balanced states. *J. Pers. Soc. Psychol.* 11:214–19
3. Allen, B. P. 1970. *The importance of race in the rating of stimulus persons attributed with beliefs that are highly congruent with the beliefs of raters: A test of a belief congruence hypothesis.* Presented at Southwest. Psychol. Assoc. Meet., St. Louis, Mo.
4. Anderson, N. H. 1971. Integration theory and attitude change. *Psychol. Rev.* 78:171–206
5. Archibald, W. P. 1970. Self-esteem and balance with impersonal attitude objects. *Psychon. Sci.* 21:363–64
6. Aronson, E. 1970. Some antecedents of interpersonal attraction. In *Nebraska Symposium on Motivation,* ed. W. J. Arnold, D. Levine, 143–73. Lincoln: Univ. Nebraska Press
7. Aronson, E., Linder, D. 1965. Gain and loss of esteem as determinants of interpersonal attractiveness. *J. Exp. Soc. Psychol.* 1:156–71
8. Aronson, E., Worchel, P. 1966. Similarity versus liking as determinants of interpersonal attractiveness. *Psychon. Sci.* 5:157–58
9. Banta, T. J., Hetherington, M. 1963. Relations between needs of friends and fiances. *J. Abnorm. Soc. Psychol.* 66:401–4
10. Baron, R. A. 1970. Attraction toward the model and model's competence as determinants of adult imitative behavior. *J. Pers. Soc. Psychol.* 14:345–51
11. Berscheid, E., Boye, D., Darley, J. M. 1968. Effect of forced association upon voluntary choice to associate. *J. Pers. Soc. Psychol.* 8:13–19
12. Berscheid, E., Dion, K., Walster, E., Walster, G. W. 1971. Physical attractiveness and dating choice: A test of the matching hypothesis. *J. Exp. Soc. Psychol.* 7:173–89
13. Berscheid, E., Walster, E. 1969. *Interpersonal Attraction.* Reading, Mass: Addison-Wesley
14. Blumberg, H. H. 1969. On being liked more than you like. *J. Pers. Soc. Psychol.* 11:121–28
15. Bond, M., Byrne, D., Diamond, M. J. 1968. Effect of occupation prestige and attitude similarity on attraction as a function of assumed similarity of attitudes. *Psychol. Rep.* 23:1167–72
16. Bonoma, T. V., Tedeschi, J. T., Lindskold, S., Horai, J. 1970. *Induced interpersonal attraction and compliance to threats.* Presented at Western Psychol. Assoc. Meet., Los Angeles
17. Brewer, R. E., Brewer, M. B. 1968. Attraction and accuracy of perception in dyads. *J. Pers. Soc. Psychol.* 8:188–93
18. Byrne, D. 1969. Attitudes and attraction. In *Advances in Experimental Social Psychology,* ed. L. Berkowitz, 4:35–89. New York: Academic
19. Byrne, D. 1971. *The Attraction Paradigm.* New York: Academic
20. Byrne, D. 1971. Can Wright be wrong? Let me count the ways. *Represent. Res. Soc. Psychol.* 2:12–18
21. Byrne, D., Baskett, G. D., Hodges, L. 1971. Behavioral indicators of interpersonal attraction. *J. Appl. Soc. Psychol.* 1:137–49
22. Byrne, D., Clore, G. L. 1966. Predicting interpersonal attraction toward strangers presented in three different stimulus modes. *Psychon. Sci.* 4:239–40
23. Byrne, D., Clore, G. L. 1967. Effectance arousal and attraction. *J. Pers. Soc. Psychol. Monogr.* 6:1–18
24. Byrne, D., Clore, G. L. 1970. A reinforcement model of evaluative responses. *Pers.: An Int. J.* 2:103–28
25. Byrne, D., Clore, G. L., Griffitt, W. 1967. Response discrepancy versus attitude similarity-dissimilarity as determinants of attraction. *Psychon. Sci.* 7:397–98
26. Byrne, D., Clore, G. L., Griffitt, W., Lamberth, J., Mitchell, H. E. When research paradigms converge: Confrontation or integration? *J. Pers. Soc. Psychol.* In press
27. Byrne, D., Clore, G. L., Worchel, P. 1966. The effect of economic similarity-dissimilarity on interper-

sonal attraction. *J. Pers. Soc. Psychol.* 4:220–24

28. Byrne, D., Ervin, C. R. 1969. Attraction toward a Negro stranger as a function of prejudice, attitude similarity, and the stranger's evaluation of the subject. *Hum. Relat.* 22:397–404
29. Byrne, D., Ervin, C. R., Lamberth, J. 1970. Continuity between the experimental study of attraction and real-life computer dating. *J. Pers. Soc. Psychol.* 16:157–65
30. Byrne, D. et al 1971. The ubiquitous relationship: Attitude similarity and attraction. *Hum. Relat.* 24: 201–7
31. Byrne, D., Griffitt, W. 1966. Similarity versus liking: A clarification. *Psychon. Sci.* 6:295–96
32. Byrne, D., Griffitt, W. 1966. A developmental investigation of the law of attraction. *J. Pers. Soc. Psychol.* 4:699–702
33. Byrne, D., Griffitt, W. 1969. Similarity and awareness of similarity of personality characteristics as determinants of attraction. *J. Exp. Res. Pers.* 3:179–86
34. Byrne, D., Griffitt, W., Golightly, C. 1966. Prestige as a factor in determining the effect of attitude similarity-dissimilarity on attraction. *J. Pers.* 34:434–44
35. Byrne, D., Griffitt, W., Hudgins, W., Reeves, K. 1969. Attitude similarity-dissimilarity and attraction: Generality beyond the college sophomore. *J. Soc. Psychol.* 79: 155–61
36. Byrne, D., Griffitt, W., Stefaniak, D. 1967. Attraction and similarity of personality characteristics. *J. Pers. Soc. Psychol.* 5:82–90
37. Byrne, D., Lamberth, J. 1971. Cognitive and reinforcement theories as complementary approaches to the study of attraction. See Ref. 118, 59–84
38. Byrne, D., London, O., Griffitt, W. 1968. The effect of topic importance and attitude similarity-dissimilarity on attraction in an intrastranger design. *Psychon. Sci.* 11: 303–4
39. Byrne, D., London, O., Reeves, K. 1968. The effects of physical attractiveness, sex, and attitude similarity on interpersonal attraction. *J. Pers.* 36:259–71
40. Byrne, D., Rhamey, R. 1965. Magnitude of positive and negative reinforcements as a determinant of attraction. *J. Pers. Soc. Psychol.* 2:884–89
41. Byrne, D., Young, R. K., Griffitt, W. 1966. The reinforcement properties of attitude statements. *J. Exp. Res. Pers.* 1:266–76
42. Carr, J. E. 1970. Differentiation similarity of patient and therapist and the outcome of psychotherapy. *J. Abnorm. Psychol.* 76:361–69
43. Clore, G. L., Byrne, D. A reinforcement-affect model of attraction. See Ref. 80
44. Clore, G. L., Gormly, J. B. 1969. *Attraction and physiological arousal in response to agreements and disagreements.* Presented at Psychon. Soc. Meet., St. Louis
45. Crandall, J. E. 1971. Effects of intolerance of ambiguity upon interpersonal attraction. *Psychol. Rep.* 28:550
46. Curry, T. J., Emerson, R. M. 1970. Balance theory: A theory of interpersonal attraction? *Sociometry* 33:216–38
47. Darley, J. M., Berscheid, E. 1967. Increased liking as a result of the anticipation of personal contact. *Hum. Relat.* 20:29–40
48. Deutsch, M., Solomon, L. 1959. Reactions to evaluations by others as influenced by self-evaluation. *Sociometry* 22:93–121
49. Efran, J. S. 1968. Looking for approval: Effects on visual behavior of approbation from persons differing in importance. *J. Pers. Soc. Psychol.* 10:21–25
50. Ellsworth, P. C., Carlsmith, J. M. 1968. Effects of eye contact and verbal content on affective response to a dyadic interaction. *J. Pers. Soc. Psychol.* 10:15–20
51. Exline, R. V., Winters, L. C. 1965. Affective relations and mutual glances in dyads. In *Affect, Cognition, and Personality*, ed. S. Tomkins, C. Izard. New York: Springer
52. Festinger, L. 1957. *A Theory of Cognitive Dissonance.* Stanford Univ. Press
53. Goldberg, G. N., Kiesler, C. A., Collins, B. E. 1969. Visual behavior and face-to-face distance during interaction. *Sociometry* 32: 43–53
54. Goldstein, J. W., Rosenfeld, H. M. 1969. Insecurity and preference for persons similar to oneself. *J. Pers.* 37:253–68

55. Gormly, J. 1971. Sociobehavioral and physiological responses to interpersonal disagreement. *J. Exp. Res. Pers.* 5:216–22
56. Gouaux, C. 1971. Induced affective states and interpersonal attraction. *J. Pers. Soc. Psychol.* 20:37–43
57. Griffitt, W. 1966. Interpersonal attraction as a function of self-concept and personality similarity-dissimilarity. *J. Pers. Soc. Psychol.* 4:581–84
58. Griffitt, W. 1969. Personality similarity and self-concept as determinants of interpersonal attraction. *J. Soc. Psychol.* 78:137–46
59. Griffitt, W. 1969. Attitude evoked anticipatory responses and attraction. *Psychon. Sci.* 14:153–55
60. Griffitt, W. 1970. Environmental effects on interpersonal affective behavior: Ambient effective temperature and attraction. *J. Pers. Soc. Psychol.* 15:240–44
61. Griffitt, W., Byrne, D., Bond, M. 1971. Proportion of positive adjectives and personal relevance of adjectival descriptions as determinants of attraction. *J. Exp. Soc. Psychol.* 7:111–21
62. Griffitt, W., Guay, P. 1969. "Object" evaluation and conditioned affect. *J. Exp. Res. Pers.* 4:1–8
63. Griffitt, W., Jackson, T. 1970. The influence of information about ability and non-ability on personnel selection decisions. *Psychol. Rep.* 27:959–62
64. Griffitt, W., Jackson, T. Simulated jury decisions: The influence of jury-defendant attitude similarity-dissimilarity. *Soc. Behav. Pers.* In press
65. Griffitt, W., May, J. Unpublished data
66. Griffitt, W., Nelson, J., Littlepage, G. 1972. Old age and response to agreement-disagreement. *J. Geront.* 27:269–74
67. Griffitt, W., Veitch, R. 1971. Hot and crowded: Influences of population density and temperature on interpersonal affective behavior. *J. Pers. Soc. Psychol.* 17:92–98
68. Griffitt, W., Veitch, R., Littlepage, G. Unpublished data
69. Heider, F. 1958. *The Psychology of Interpersonal Relations.* New York: Wiley
70 Hendrick, C., Bixenstine, V. E., Hawkins, G. 1971. Race versus belief similarity as determinants of attraction: A search for a fair test. *J. Pers. Soc. Psychol.* 17:250–58
71. Hendrick, C., Brown, S. R. 1971. Introversion, extraversion, and interpersonal attraction. *J. Pers. Soc. Psychol.* 20:31–36
72. Hendrick, C., Page, H. A. 1970. Self-esteem, attitude similarity, and attraction. *J. Pers.* 38:588–601
73. Hicks, M. W., Platt, M. 1970. Marital happiness and stability: A review of research in the sixties. *J. Marriage Fam.* 32:553–74
74. Hodges, L., Byrne, D. 1972. Verbal dogmatism as a potentiator of intolerance. *J. Pers. Soc. Psychol.* 21:312–17.
75. Hoffman, L. R. 1958. Similarity of personality: A basis for interpersonal attraction? *Sociometry* 21: 300–8
76. Hoffman, L. R., Maier, N. R. F. 1966. An experimental re-examination of the similarity-attraction hypothesis. *J. Pers. Soc. Psychol.* 3:145–52
77. Holstein, C. M., Goldstein, J. M., Bem, D. J. 1971. The importance of expressive behaviors, involvement, sex, and need-approval in induced liking. *J. Exp. Soc. Psychol.* 7:534–44
78. Homans, G. C. 1961. *Social Behavior: Its Elementary Forms.* New York: Harcourt, Brace & World
79. Huffman, D. M. 1969. *Interpersonal attraction as a function of behavioral similarity.* PhD thesis. Univ. Texas, Austin
80. Huston, T. L., Ed. *Perspectives on Interpersonal Attraction.* New York: Academic. In press
81. Insko, C. A., Robinson, J. E. 1967. Belief similarity versus race as determinants of reactions to Negroes by southern white adolescents: A further test of Rokeach's theory. *J. Pers. Soc. Psychol.* 7:216–21
82. Izard, C. E. 1960. Personality similarity and friendship. *J. Abnorm. Soc. Psychol.* 61:47–51
83. Jacobs, L., Berscheid, E., Walster, E. 1971. Self-esteem and attraction. *J. Pers. Soc. Psychol.* 17:84–91
84. Jones, E. E. 1964. *Ingratiation.* New York: Appleton-Century
85. Jones, E. E., Bell, L., Aronson, E. 1972. The reciprocation of attraction from similar and dissimilar others: A study in person perception and evaluation. In *Experi-*

mental Social Psychology, ed. C. G. McClintock. New York: Holt

86. Jones, E. E., Sigall, H. 1971. The bogus pipeline: A new paradigm for measuring affect and attitude. *Psychol. Bull.* 76:349–64

87. Jones, Q. A., Moyel, I. S. 1971. The influence of iris color and pupil size on expressed affect. *Psychon. Sci.* 22:126–27

88. Kaplan, M. F., Anderson, N. H. Information integration theory and reinforcement theory as approaches to interpersonal attraction. *J. Pers. Soc. Psychol.* In press

89. Kerckhoff, A. C., Davis, K. E. 1962. Value consensus and need complementarity in mate selection. *Am. Sociol. Rev.* 27:295–303

90. Kiesler, C. A., Goldberg, G. N. 1968. Multi-dimensional approach to the experimental study of interpersonal attraction: Effect of a blunder on the attractiveness of a competent other. *Psychol. Rep.* 22: 693–705

91. Kiesler, C. A., Kiesler, S. B. 1969. *Conformity*. Reading, Mass: Addison-Wesley

92. Krebs, D. L. 1970. Altruism—an examination of the concept and a review of the literature. *Psychol. Bull.* 73:258–302

93. Kuhn, T. S. 1970. *The Structure of Scientific Revolutions.* Univ. Chicago Press

94. Lamberth, J. 1971. Sequential variables as determinants of human performance with attitudinal reinforcements. *Psychon. Sci.* 22:350–52

95. Landy, D., Aronson, E. 1969. The influence of the character of the criminal and his victim on the decisions of simulated jurors. *J. Exp. Soc. Psychol.* 5:141–52

96. Latané, B., Hothersall, D. Social attraction in animals. In *Psychology 72*, ed. P. C. Dodwell. New York: Penguin. In press

97. Lerner, M. J. 1965. Evaluation of performance as a function of performer's reward and attractiveness. *J. Pers. Soc. Psychol.* 1:355–60

98. Lerner, M. J. 1965. The effect of responsibility and choice on a partner's attractiveness following failure. *J. Pers.* 33:178–87

99. Lerner, M. J., Dillehay, R. C., Sherer, W. C. 1967. Similarity and attraction in social contexts. *J. Pers. Soc. Psychol.* 5:481–86

100. Levinger, G. 1965. Marital cohesiveness and dissolution: An integrative review. *J. Marriage Fam.* 28:19–28

101. Levinger, G. 1972. Little sand box and big quarry: Comment on Byrne's paradigmatic spade for research on interpersonal attraction. *Represent. Res. Soc. Psychol.* 3:3–19

102. Levinger, G., Gunner, J. 1967. The Interpersonal Grid I. Felt and tape techniques for the measurement of social relationships. *Psychon. Sci.* 1:173–74

103. Levinger. G., Moreland, J. 1969. Approach-avoidance as a function of imagined shock threat and self-other similarity. *J. Pers. Soc. Psychol.* 12:245–51

104. Levinger, G., Snoek, J. D. 1972. *Attraction in Relationship: A New Look at Interpersonal Attraction.* New York: General Learning

105. Lindzey, G., Byrne, D. 1968. Measurement of social choice and interpersonal attractiveness. In *Handbook of Social Psychology*, ed. G. Lindzey, E. Aronson, 2: 452–525. Reading, Mass: Addison-Wesley

106. Little, K. B. 1965. Personal space. *J. Exp. Soc. Psychol.* 1:237–47

107. Lombardo, J. P., Weiss, R. F., Stich, M. H. 1971. Interpersonal attraction as a function of amount of information supporting the subject's opinions. *Psychon. Sci.* 24: 79–80

108. Lott, A. J., Aponte, J. F., McGinley, W. H., Lott, B. E. 1969. The effect of delayed reward on the development of interpersonal attraction. *J. Exp. Soc. Psychol.* 5: 101–13

109. Lott, A. J., Lott, B. E. 1968. A learning theory approach to interpersonal attitudes. In *Psychological Foundations of Attitudes*, ed. A. G. Greenwald, T. C. Brock, T. M. Ostrom, 67–88. New York: Academic

110. Lott, A. J., Lott, B. E. 1971. The power of liking: Consequences of interpersonal attitudes derived from a liberalized view of secondary reinforcement. See Ref. 18, Vol. 6

111. Lowe, C. A., Goldstein, J. W. 1970. Reciprocal liking and attributions

of ability: Mediating effects of perceived intent and personal involvement. *J. Pers. Soc. Psychol.* 16: 291–97

112. Mehrabian, A. 1968. Inference of attitudes from the posture, orientation, and distance of a communicator. *J. Consult. Clin. Psychol.* 32:296–308
113. Miller, N., Campbell, D. T., Twedt, H., O'Connell, E. J. 1966. Similarity, contrast, and complementarity in friendship choice. *J. Pers. Soc. Psychol.* 3:3–12
114. Mischel, W., Grusec, J. 1966. Determinants of the rehearsal and transmission of neutral and aversive behaviors. *J. Pers. Soc. Psychol.* 3:197–205
115. Mitchell, H. E., Byrne, D. The defendant's dilemma: Effects of jurors' attitudes and authoritarianism on judicial decisions. *J. Pers. Soc. Psychol.* In press
116. Moss, M. K. 1969. *Social desirability, physical attractiveness, and social choice.* PhD thesis. Kansas State Univ., Manhattan
117. Murstein, B. I. 1970. Stimulus-value-role: A theory of marital choice. *J. Marriage Fam.* 32:465–81
118. Murstein, B. I., Ed. 1971. *Theories of Attraction and Love.* New York: Springer
119. Ibid. Critique of models of dyadic attraction, 1–30
120. Newcomb, T. M. 1961. *The Acquaintance Process.* New York: Holt, Rinehart & Winston
121. Newcomb, T. M. 1968. Interpersonal balance. See Ref. 1, 28–51
122. Novak, D. W., Lerner, M. J. 1968. Rejection as a function of perceived similarity. *J. Pers. Soc. Psychol.* 9:147–52
123. Nowicki, S. Jr. 1971. Ordinal position, approval motivation, and interpersonal attraction. *J. Consult. Clin. Psychol.* 36:265–67
124. Osgood, C. E., Suci, G. J., Tannenbaum, P. H. 1957. *The Measurement of Meaning.* Urbana: Univ. Illinois Press
125. Palmer, J. 1969. *Vindication, evaluation, and the effect of the stranger's competence on the attitude similarity attraction function.* PhD thesis. Univ. Texas, Austin
126. Palmer, J., Byrne, D. 1970. Attraction toward dominant and submissive strangers: Similarity versus complementarity. *J. Exp. Res. Pers.* 4:108–15
127. Phares, E. J., Wilson, K. G. 1971. Internal-external control, interpersonal attraction, and empathy. *Psychol. Rep.* 28:543–49
128. Reagor, P. A., Clore, G. L. 1970. Attraction, test anxiety, and similarity-dissimilarity of test performance. *Psychon. Sci.* 18:219–20
129. Reitz, W. E., Douey, J., Mason, G. 1968. Role of homogeneity and centrality of attitude domain on reinforcing properties of attitude statements. *J. Exp. Res. Pers.* 3:120–25
130. Rokeach, M., Smith, P. W., Evans, R. I. 1960. Two kinds of prejudice or one? In *The Open and Closed Mind,* ed. M. Rokeach. New York: Basic Books
131. Rubin, Z. 1970. Measurement of romantic love. *J. Pers. Soc. Psychol.* 16:265–73
132. Schlenker, B. R., Bonoma, T. V., Tedeschi, J. T., Lindskold, S., Horai, J. 1971. The effects of referent and reward power on social conflict. *Psychon. Sci.* 24:268–70
133. Schlenker, B. R., Tedeschi, J. T. Interpersonal attraction and the exercise of coercive and reward power. *Hum. Relat.* In press
134. Senn, D. J. 1971. Attraction as a function of similarity-dissimilarity in task performance. *J. Pers. Soc. Psychol.* 18:120–23
135. Sherman, R. C. Social perception and initial liking as a function of prior exposure to an arousing situation, target variability, and attitude similarity-dissimilarity. *Percept. Mot. Skills.* In press
136. Sigall, H., Page, R. 1971. Current stereotypes: A little fading, a little faking. *J. Pers. Soc. Psychol.* 18:247–55
137. Skolnick, P. 1971. Reactions to personal evaluations: A failure to replicate. *J. Pers. Soc. Psychol.* 18:62–67
138. Smith, R. E. 1970. *Social anxiety as a moderator variable in the attitude similarity-attraction relationship.* Presented at Western Psychol. Assoc. Meet., Los Angeles
139. Smith, R. E., Meadow, B. L., Sisk, T. K. 1970. Attitude similarity, interpersonal attraction, and evaluative social perception. *Psychon. Sci.* 18:226–27
140. Staats, A. W. 1968. Social behavior-

ism and human motivation: Principles of the attitude-reinforcer-discriminative system. See Ref. 109, 33–66

141. Stass, A. W., Willis, F. N. Jr. 1967. Eye contact, pupil dilation, and personal preference. *Psychon. Sci.* 7:375–76
142. Stein, D. D., Hardyck, J. A., Smith, M. B. 1965. Race and belief: An open and shut case. *J. Pers. Soc. Psychol.* 1:281–89
143. Stephan, W., Berscheid, E., Walster, E. 1971. Sexual arousal and heterosexual perception. *J. Pers. Soc. Psychol.* 20:93–101
144. Stroebe, W., Insko, C. A., Thompson, V. D., Layton, B. D. 1971. Effects of physical attractiveness, attitude similarity, and sex on various aspects of interpersonal attraction. *J. Pers. Soc. Psychol.* 18:79–91
145. Tagiuri, R. 1969. Person perception. See Ref. 105, 3:395–449
146. Tajfel, H. 1969. Social and cultural factors in perception. See Ref. 105, 3:315–94
147. Taylor, H. F. 1970. *Balance in Small Groups.* Princeton, N. J.: Van Nostrand-Reinhold
148. Tesser, A. 1971. Evaluative and structural similarity of attitudes as determinants of interpersonal attraction. *J. Pers. Soc. Psychol.* 18:92–96
149. Thibaut, J. W., Kelley, H. H. 1959. *The Social Psychology of Groups.* New York: Wiley
150. Triandis, H. C. 1961. A note on Rokeach's theory of prejudice. *J. Abnorm. Soc. Psychol.* 62:184–86
151. Triandis, H. C., Loh, W. D., Levin, L. A. 1966. Race, status, quality of spoken English, and opinions about civil rights as determinants of interpersonal attitudes. *J. Pers. Soc. Psychol.* 3:468–72
152. Walster, E. 1965. The effect of self-esteem on romantic liking. *J. Exp. Soc. Psychol.* 1:184–87
153. Ibid 1970. The effect of self-esteem on liking for dates of various social desirabilities. 6:248–52
154. Walster, E. 1971. Passionate love. See Ref. 118, 85–99
155. Walster, E., Aronson, V., Abrahams, D., Rottmann, L. 1966. Importance of physical attractiveness in dating behavior. *J. Pers. Soc. Psychol.* 4:508–16
156. Winch, R. F., Ktsanes, T., Ktsanes, V. 1955. Empirical elaboration of the theory of complementary needs in mate selection. *J. Abnorm. Soc. Psychol.* 51:508–13
157. Wright, P. H. 1969. A model and a technique for studies of friendship. *J. Exp. Soc. Psychol.* 5:295–309
158. Wright, P. H. 1971. Byrne's paradigmatic approach to the study of attraction: Misgivings and alternatives. *Represent. Res. Soc. Psychol.* 2:66–70
159. Zander, A., Havelin, A. 1960. Social comparison and interpersonal attraction. *Hum. Relat.* 13:21–32
160. Zimbardo, P., Formica, R. 1963. Emotional comparison and self-esteem as determinants of affiliation. *J. Pers.* 31:141–62

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THE STUDY OF SMALL GROUPS

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The reviewer facing the research reported in the area of small groups between 1967 and 1972[3] is both impressed by the quantity of data presented and depressed by the general absence of excitement and new theoretical formulations. The area loosely defined as group dynamics has never been characterized by a unifying theoretical position. *Psychological Abstracts* lists roughly 3400 studies related to groups since the last review by Gerard & Miller (44). A large proportion of this research seems to be following established lines of investigation with little or no concern for external validity or potential applications. From the point of advancing the field, it may be that much of this research comes closer to exemplifying a psychological Gresham's Law that "bad research drives out good" than Kurt Lewin's notion that "nothing is so practical as a good theory."

Our disenchantment with both the theoretical and the mundane significance of much of the past decade's literature (as well as the pragmatic impossibility of achieving a comprehensive review) has dictated an eclectic and biased approach to our topic. At this time it appears that the questions asked (or unasked) are more intriguing than the answers produced to date. We have, therefore, concentrated on approaches where methodology, theoretical impact, or application seem most promising, and have attempted to cite reviews summarizing research in those areas we have slighted.

Several recent works of general interest to the student of small groups are worthy of note. The revised edition of Cartwright & Zander (21) remains an excellent general introduction to group dynamics. The second edition of the *Handbook of Social Psychology* (73) also contains several relevant chapters by Lindzey & Byrne (74), Tagiuri (117), Kelley & Thibaut (67), Collins & Raven (23), and Gibb (45). A work of value to students of groups in isolation and under stress is a National Academy of Science volume, *Human Factors in Long Duration Spaceflight* (91).

METHODOLOGY

It seems currently fashionable to issue critiques of laboratory research while

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[3] The survey of literature pertaining to this review was concluded in February 1972.

extolling field investigations. It is certainly not an evil, nor even a new fashion; nor does it necessarily involve a flight from experimentation, as a recent book of readings edited by McClintock (82) so clearly demonstrates. Rather than pile methodological polemic on the reader, McClintock's book organizes itself around presentations of representative experimental research paradigms, allowing the reader first to feel for himself and then to judge the methodologies and research strategies given. The organizers of this volume believe that the experimental method is rather on the defensive, and its authors seem well aware that the last few decades of experimentation have produced little "theoretically meaningful knowledge," as Harold Proshansky notes in the Foreword. The argument that this uncomfortable fact stems more from practitioners than from methodological limitations is made implicit by good counter-example and explicit in a fine concluding statement by Daniel Katz (65).

While those in Watson's shadow introspect about the meaning of their experimental acts, Irving Goffman (who is uniquely himself, but still is somewhat from Mead's mold) continues his sympathetic observations. In *Relations in Public: Microstudies of the Public Order* (46), Goffman, in additional to the usual insightful analysis we have come to expect from him, even mentions methodological issues. Identifying his own work as often "unsystematic, naturalistic observation," he suggests that after some years of others' more scientific work: "Understanding of ordinary behavior has not accumulated; distance has" (p. xvi). For different and quite well qualified reasons, Katz does not altogether disagree. As he notes: "Of the thousands of experimental studies published in social psychology in the past 20 years, the number that supplies new information to a cumulative body of knowledge is surprisingly small" (65, p. 557).

Not surprisingly, most of the methodological innovations worthy of note are in the area of naturalistic research. One excellent source is Karl Weick's (128) chapter on systematic observation in the *Handbook of Social Psychology*. Much of the methodological impetus seems to be coming from sociology where problems of objective coding of natural phenomena and the treatment of extensive longitudinal data are receiving much-deserved attention. Of particular interest is a chapter by Reiss (102) in *Sociological Methodology, 1971*. Several applications of a systematic observational methodology have also been made to isolated groups by Radloff & Helmreich and their associates (55, 100).

One of the important aspects of systematic observation of natural phenomena over time is the accumulation of archives of longitudinal data. The vast majority of studies of social psychological effects have dealt with *acute* reactions assessed, if more than once, over a brief period of time. The result has been a paucity of solid research tracing patterns of response over extended periods of time. Along with the lack of longitudinal, repeated measures studies has gone a lack of involvement with statistical techniques for analysis of multivariate repeated measures designs and procedures for making causal inferences from such data. Again, more developments seem to have taken place in sociology than in psychology. Path analysis provides one fruitful approach to the search for causal inference from correlational data. Numerous discussions of this technique have appeared since Blalock's (15) pioneering work and a subsequent edited volume by Blalock & Blalock (16). Among the more recent papers are those of Heise (54), Hauser & Goldberger (52), Land (71), and Lyons (76). It seems likely that such approaches to the study of small groups over time will become a favored methodology in the next few years.

ATTRACTION

Recent works in the area of attraction include Berscheid & Walster's *Interpersonal Attraction* (14), which is an excellent summary of research in attraction, and Elliot Aronson's (6) presentation in the *Nebraska Symposium.* Aronson notes that it is easy to group most antecedents of attraction into a general cost reward model but that it is very difficult to specify a priori events and situations which are rewarding. Aronson's approach involves presenting mini-theories such as the pratfall effect (Aronson, Willerman & Floyd 9) and a gain-loss model (Aronson & Linder 8, Sigall & Aronson 110) which are exceptions to the general notions of reward. It seems appropriate here to point out that the mini-theory of gain-loss is easily subsumed under a general notion developed from Prisoner's Dilemma-style research. Stuart Oskamp (95), in surveying effects of different strategies, notes that "The organization or patterning of programmed input is much more important than the overall level of reinforcement in determining subjects' responses."

Bernard Murstein has edited a recent book, *Theories of Attraction and Love* (90), which includes the latest theoretical statements by Newcomb, Homans, Walster, and Murstein on attraction. In this eclectic book Newcomb (93) clarifies some issues regarding P/O relationships in the balance model, Homans (60) speculates on attraction relating to positive sanction power, Walster (126) defines passionate love in terms of Schachter's two-component theory of emotionality, and Murstein presents a theory of marital choice.

In the field of attraction the concept of what can be researched has broadened in the last 5 years. New approaches suggest that love is more than intense liking, as Heider (53) proposed. Rubin (105), in an attempt to introduce and validate a social psychological construct of love, begins by assuming that love is an interpersonal attitude. In his love scale the concept of romantic love includes three components: affiliative and dependent need, a predisposition to help, and an orientation of exclusiveness and absorption. Another assumption is that love is a distinctly different concept from interpersonal attraction. Rubin found a positive correlation between scores on his refined love scale and the amount of time loving couples spent gazing into one another's eyes. Walster (126) agrees that love is distinct from attraction in that it need not be engendered by reward. Walster notes that love may co-exist in settings with aggression, hatred, and rejection—none of which is a breeding ground for attraction. In terms of Schachter's (106) theory of emotionality, love is engendered by a combination of psychological arousal and an appropriate label toward a love object. The arousal may be either negative as with fear, frustration, and rejection, or positive as with sexual gratification and need satisfaction. What is most important is being aroused in an appropriate labeling situation.

Many of the criticisms of past and present attraction research relate intimately to the methodology. For attraction, particularly relevant points are concerned with short interaction times and mythical strangers. Murstein has propounded a theory of martial selection which takes into account the changing needs and rewards over the development of a relationship. Stimulus-value-role theory (S-V-R) assumes that an individual first considers salient stimulus characteristics such as age and physical attractiveness relative to his own. According to social exchange, if the assets and rewards are perceived to be roughly equivalent, then the relationship is eligible to progress into the value stage where attitudes, temperament, and ability to relate are evaluated. Homogeneity is considered most rewarding in both the stimulus and value stages, but as the relationship filters to the role stage, parsimony yields to the increasing intensity of interaction. Roles of the couple must be interactive in order to mediate goals, and therefore it is meaningful to think in terms of role fit rather than homogeneity or complementarity. Murstein admits that S-V-R theory is eclectic and in need of integration by further research, but it is a needed step forward in assessing longitudinal data on real relationships.

Another new approach is that of Kiesler & Goldberg (68), who have raised the seemingly repressed question of multidimensionality in interpersonal attraction. Findings from a factor analytic study indicate that socioemotional and task related groups account for different but interdependent sources of attraction. It may be possible to like someone in one role and dislike him in another. Homans (60) maintains, in a similar vein, that much of the ambiguity of what we mean by attraction lies in the mixture of emotional and instrumental responses.

The majority of attraction research published in the last 5 years has been couched in a reward framework. Most of the research concerned with reward investigates aspects of the similarity and attraction relationship. Similarity expressed in gestures (Dabbs 28), in personality traits (Griffitt 49), in test performance (Reagor & Clore 101), and in attitudes (Byrne & Lamberth 18) has shown a positive relationship with attraction. Donn Byrne, one of the more prolific researchers concerned with attitude similarity and attraction, has conceptualized attraction as a form of information processing in which attraction varies in any part of the informational sequence according to the proportion of similar attitudes in the preceding series. Similar attitudes, according to Byrne (18), are reinforcing by mediating reward for an effectance motive. Ettinger, Nowicki & Nelson (35) explain the mechanism of attraction to similar attitudes by an approval cue hypothesis and by social learning. Attraction is viewed as a function of the expectancy of approval and the reinforcement value associated with approval.

Marsden (80) has raised the question that perceived similarity and not actual similarity may be the crucial variable. The amount of similarity was compared among three levels of friendship and between friends and nonfriends. The results indicate that there is no more similarity among very good friends than among casual friends or between friends and nonfriends. Rosenblood & Goldstein (104) also found that when subjects were given a choice, they chose to affiliate more on the basis of intelligence than as a function of similarity. Sigall & Aronson (111) and Worchel & Schuster (133) indicate that a gain in agreement over prior disagreement induces higher levels of attraction than does constant agreement.

Generally there is a positive relationship between eye contact and attraction. Mehrabian (84) indicates that eye contact, distance, orientation, and relaxation of the body are significant indices of an individual's liking [which is not surprising given popularized notions of body language such as that of Fast (36)]. Individuals who maintain eye contact are more likely to be chosen (Stass & Willis 114), and individuals who maintain long gazes are liked more than individuals who look in short frequent gazes. Too much eye contact, however, may cause discomfort; Argyle & Dean (5) indicate that intimacy (as defined by eye contact, smiling, and physical proximity) has acceptable limits. To remain in equilibrium, the individual may decrease eye contact when physical proximity increases. Stephenson & Rutter (115) have challenged Argyle & Dean's affiliation-conflict model by explaining increased eye contact at farther distances as an artifact of observed behavior. There are, however, three replications which support the affiliation-conflict model (Goldberg, Kiesler & Collins 47, White, Hegarty & Beasley 129, Argyle 4).

CONFORMITY AND SOCIAL INFLUENCE

In contrast to studies of interpersonal attraction and love, research in conformity and social influence has been greatly influenced for many years by one research strategy. Few research designs in social psychology have been as seminal as the Asch conformity situation. Not only has this situation spawned numerous studies, it has fertilized ideas even beyond its own field. Efficient symbols that encode much information are indeed used. Perhaps the Asch situation is such an economical symbol, condensing in one simple, experimental paradigm a wider concern with conformity and social influence. The last few years have seen their share of Asch-inspired studies: occasionally the stimulus is varied; often variables (such as fear) that affect conformity are explored. Two such studies will be mentioned here; both apply the Asch situation in different cultural settings and each illustrates nicely one of the four types of cross-cultural research from Fred Strodtbeck's (116) taxonomy.

Cultures can be viewed as natural manipulations. The problem of stimulus and response equivalence within this culture-as-independent variable model has hardly gone unnoticed. Still, a study by Berry (13) seems to avoid the usual pitfalls. Following the Murdockian (89) categorization of subsistence societies into low and high food accumulators (hunters vs farmers, fishermen vs shepherds), Berry predicted that low food accumulators should exhibit less conformity. Presumably this is because such societies have developed socialization practices in accord with their economic needs (an idea developed by Barry, Child & Bacon 11). Using samples of Baffin Island Eskimos and Temne people from Sierra Leone, Berry finds that the Temne do indeed exhibit significantly more conformity than do the low food accumulating Eskimos.

For different reasons, but likewise a priori, Robert Frager (41) predicted high levels of conformity for Japanese subjects. Often cross-cultural research necessitates revision in the experimenter's culturally given taxonomy (Strodtbeck's type III); not surprisingly then, "surprising" phenomena are more frequently encountered in cross-cultural work. Frager's results are surprising: more than a third of his subjects exhibited anticonformity, that is, gave incorrect responses when the group gave correct ones. This sort of response had not appeared spontaneously in previously reported work. Willis & Hollander (132) did demonstrate anticonformity, as reported by Gerard & Miller, but only as some movement in the direction of anticonformity over trials, accompanied by strong manipulations designed to induce anticonforming responses: anticonformity was defined as disagreeing with a single other labeled unreliable by the experimenter.

Frager found a significant correlation between anticonforming responses and alienation. Several questions might now be asked. Is anticonformity unique to Japanese populations, or, if it were to appear elsewhere, would it again be tied to alienation? Certainly pressure to conform is present in all societies, albeit in differing amounts, as Berry's study suggests. But Frager's research should stimulate us to question what differing forms conforming responses might take. And certainly both studies together should serve to remind us, if reminding is necessary, of the cultural brackets that surround our almost casual use of the words *person* and *people* in social psychological research.

Far from the laboratory, a type of material exists which, although not in the psychological main stream, is clearly relevant to, and should be used by, students of social influence. An example of such a work would be the memoirs of Albert Speer (113). Here is a thoughtful book, by a man who has had much time to think, concerning his own participation in a group which exerted, successfully for a time, incredibly strong pressures on its members to conform to certain group norms regarding appropriate intellectual assumptions, interpretations of events, and behavior. The social reality thus created, although at variance with others in the world, had immense consequences for many. It would seem Nero-like for social scientists to ignore such potent phenomena while fiddling with laboratory data.

It is encouraging to see social-historical data skillfully dealt with by Irving Janis. In *Groupthink* (64) Janis delineates with theoretical distance what Speer describes with immediacy. Somehow it seems correct that a social psychologist should turn his hand to interpreting social-historical data in the light of social-psychological theory. We are not arguing here that laboratory generated data are of dubious value or of questionable generality, or even that sole reliance on experimental data causes theoretical rickets. Rather, we would simply suggest that, given the data-rich world we live in, the researcher would do well to wonder whether he wants to bring more, possibly dubious, data into this world, or whether theory would not be better served by adapting much existing data to psychological use.

Still, laboratory data, quite apart from the experimental/nonexperimental issue, has a place. People will wait hours in line to see cleverly constructed automata, almost indistinguishable from humans, deliver messages that likely wouldn't be listened to were the speakers merely human. This fascination with the artificial may in part account for the power laboratory demonstrations have: precisely because they are not real, they are more believed. Clearly, we cannot do without them. Yet there is a heavy irony in the fact that while real killing can pass without comment, a study like that of Milgram (85) moves people to outrage. The most recent, and perhaps one of the best, laboratory demonstrations of the power of social reality is provided by Philip Zimbardo's model prison (139). So rapidly did normal and relatively homogeneous young men change their behavior in conformity with their randomly assigned "guard" or "prisoner" status, that after 6 days of a projected 2-week experiment, the experimenter-warden closed down his mock prison.

The upset generated by a Milgram or a Zimbardo, both from the public and from their colleagues, in part stems from ethical concerns. But another part of their power lies precisely in their demonstration of how strong situational determinants are in shaping behavior. No resort to a correlation between "those" people who do "evil" things is allowed: the subjects were randomly assigned. It is the experimental method, not a fascination with the artificial, that convinces.

Milgram's and Zimbardo's studies evoke public outcry in part because, through shaming dramatizations, they remind us just how fragile our ethical independence and integrity really are. The common link between the two studies is their mutual reliance on an authority figure who legalizes the punishment the subject-teachers or subject-guards are allowed to administer. The experimenter-teacher or experimenter-warden tacitly accepts the ultimate ethical responsibility for the victims, thus relieving the actors of that obligation. What follows in each situation is all too familiar to the student of history.

Another type of social influence, albeit negative, has been carefully investigated by Darley & Latané (29) in their studies of bystander intervention in crisis situations. In a series of ingenious studies they have found that the more people present at the onset of an emergency, the less likely an onlooker is to render assistance. This phenomenon is not due to apathy or a generalized urban unconcern, but rather seems to occur because the presence of strangers may inhibit noticing an emergency and/or may lead to a definition of the situation as not requiring action. In any event, Darley & Latané have isolated and clarified an interesting aspect of group behavior.

Cooperation and competition.—The study of cooperation and competition in social settings seems to have tended almost inexorably toward the use of the Prisoner's Dilemma paradigm. The dilemma for the reviewer is in evaluating the overwhelming proliferation of such studies. The sheer bulk of PD studies and the absence of notable theoretical integration and advance seem to demonstrate that an attempted *via definitiva* may become a *via dolorosa*.

Yet a fine review book has appareared recently: *Cooperation and Competition: Readings on Mixed-Motive Games*, (edited by Wrightsman, O'Connor, and Baker 134). The book is thoughtful and well organized, demonstrates a fine sensitivity to the issues in the research, and provides pithy introductions and summaries for its various sections. Further, the book includes earlier reviews in the area, most notably Gallo & McClintock's (43) article (indeed, the authors intend their book to be a review and update of Gallo & McClintock's conclusions) and Stuart Oskamp's more recent (95) work. In addition, the book contains a classified bibliography of some 1100 references. For those interested in gaming research, Wrightsman, O'Connor & Baker's book seems to be a logical first choice. Nor are the editors content merely to summarize. The book goes beyond box scores and addresses itself to what is perhaps the central problem to those observing the area from outside—the generalizability of results. A quote from a section entitled The Relevance of Mixed-Motive Games will illustrate: "If subjects play for real money instead of imaginary money, degree of cooperation may be positively affected, adversely affected, or affected not at all." The intent of this somewhat out of context quote is neither to prove that the authors are unsophisticated (they are not), nor to show them droll. Rather, it points up nicely a problem which pervades Prisoner's Dilemma-style research.

Critics of psychological experimentation question the creation in the laboratory of behaviors that do not exist otherwise. A quote such as the above can only be grist for this particular mill. The reader may recall that Von Neumann & Morgenstern, when extending their *Theory of Games and Economic Behavior* (122) to the non-zero-sum case, found it necessary to introduce a fictitious player who can have no influence on the course of the game. Perhaps in extending non-zero-sum games to the world of international politics, it is the results which are fictions and likewise have no influence. Perhaps a research question well-rooted in real-world concerns should now concern at least some of us. It is: what is the effect on a field that reinforces investigations of such variables as real vs imaginary money?

PERFORMANCE

Performance covers a variety of topics dealing with factors affecting individual and group output and serves primarily as a convenient umbrella under which to gather a wide range of research. Theoretical and applied concern with performance remains high as does research output. We will attempt only to provide the flavor of what seem to be primary interests.

Social facilitation.—Credit must be given to Nicholas Cottrell (25) for his methodological and conceptual treatment of recent theoretical advances in the study of social facilitation. Cottrell outlines the developing relationship between data and theory with attention to methodological issues. The old question, "What is the effect of the mere presence of other individuals upon the performance of the single individual?" (27) remains a source of research interest. However, no clear statement regarding the inconsistency of results had been made until Zajonc (135, 136) proposed an hypothesis which can account for a number of conflicting data. Zajonc maintains that the mere presence of another individual whether co-acting or observing increases the general drive state and therefore the likelihood that the dominant response will be made, assuming that a higher drive state inhibits the acquisition of new responses. Receptivity to the idea has been favorable and research is likewise supporting (Tolman 119, Zajonc et al 138, Matlin & Zajonc 81, and Zajonc, Heingartner & Herman 137). Cottrell (24) has proposed that the presence of others is a learned source of drive and not an innate biological drive. Cottrell compared an alone condition with an observed and a blindfolded observer condition. Although blindfolded others are in the mere presence of the subjects (as Zajonc stated), subjects' performance did not differ significantly from the alone condition. Cottrell suggests that the presence of others is drive inducing to the extent that they are perceived as being evaluative. Henchy & Glass (56) and Paulus & Murdock (96) support Cottrell's qualification by reporting greater social facilitation effects when the subject is told that he is being evaluated by experts. It is assumed that at birth the mere presence of another individual is motivationally neutral and that drive is learned through social experience.

Task performance.—Performance research has been singularly concerned with task, group size, and group composition. The notions of group member interaction and the interaction between group composition and situational variables such as task meaningfulness have received less attention. The researchers on group performance have been well socialized in the S-R or S-O-R paradigm. There are, however, a few worthy attempts to conceptualize and operationalize a multivariate approach. O'Brien & Owens (94) found that group productivity is a function of the interaction between member ability, interpersonal relations, position structure, and kind of task. Contrary to laboratory expectations, Freidlander (42), studying 12 work groups in a research organization, found that group effectiveness was correlated negatively with occupational and educational level, heterogeneity, and group size. Tuckman (120) attempted to demonstrate the interactive and additive effects of group heterogeneity on task structure. Groups of intermediate heterogeneity displayed less tendency to structure their tasks and outperformed homogeneous groups. Naylor & Dickinson (92) examined the relationship between task structure and task organization on task performance and found that task structure was the more powerful in influencing achievement, consistency, and matching. The importance of variations in task structure alone was the topic of several multivariate studies (Hackman 50, Altman 2, and Morris 88).

There has been a dearth of literature in the group performance area which considers changes over time. Group performance may be conceptualized as a process with variables which influence one another in dynamic feedback patterns. Laboratory research has been important in recognizing the large number of task, motivational, leadership, and personality variables; however, what now seems to be needed are constructs which will begin to integrate the myriad relevant variables into predictable and exploratory patterns capable of explaining trends over time.

Risky shift.—Individuals have been shown to choose riskier alternatives when making decisions in a group than when deciding alone. Perhaps because the risky shift is counterintuitive (i.e. Whyte 130, Allport 1) and offers so many possible interpretations, it has become one of the most active research areas concerned with group process. The risky shift paradigm is regarded as a carefully controlled, standardized method of viewing the essence of a group's effects upon individual attitudes. The issue has stimulated research from widely disparate positions including leadership (Marquis 79, Wallach, Kogan & Burt 124), diffusion of responsibility (Pruitt & Teger 99, Secord & Backman 108, Wallach, Kogan & Bem 123), and familiarization (Bateson 12, Flanders & Thistlethwaite 40). When so many studies are generated simultaneously there is less opportunity for inter-researcher communication and evaluation. For those interested in a recent review, Dion, Baron & Miller (30) have written an excellent chapter nicely organizing theory with data.

An early explanation of the risky shift was responsibility diffusion. The intervening mechanism proposed was that, to reduce fear of failure, individuals would diffuse their responsibility by forming affective bonds with other group members. Although responsibility diffusion remains theoretically alive, the mechanism of affective bounds has not fared well. Dion, Miller & Magnan (31) and Vidmar (121) found that less cohesive, more heterogeneous groups exhibited a greater risky shift than did cohesive and homogeneous groups.

Leader behavior has also been proposed as the cause of risky shifts, presumably because leaders prefer riskier alternatives and influence others. The research investigating this explanation has provided only weak support and has typically employed indirect correlations between riskiness and persuasion. Research directed at manipulating leadership as a controlled variable or directly assessing the effects of the influence process is lacking.

Empirically, the best supported explanation of the risky shift was proposed by Roger Brown (17). According to Brown, risk is a value in our culture. Levinger & Schneider (72) and Pilkonis & Zanna (97) reported that individuals typically select odds riskier than their own when asked to select a level of risk taking which they most admire. Madaras & Bem (78) found greater preference for risk than for caution on items which were found to produce a risky shift. The two mechanisms which Brown proposed are: (*a*) individuals perceive themselves as relatively risky; and (*b*) given relevant information about others' risk level, shift to positions of greater risk. Evidence that individuals perceive themselves as relatively risky has been presented by Willems (131), Baron et al (10), Hinds (58), and Levinger & Schneider (72).

LEADERSHIP

The attempts to isolate consistent leadership traits in the 1930s and 1940s were somewhat disappointing. The situational approach employed in the 1950s likewise failed to provide a meaningful analysis of leadership. Increasingly as Hollander & Julian (59) noted in their excellent review, the leader is viewed as a central element in a process involving interactions between leader, group, and task.

Fiedler (37), in his contingency model of leader effectiveness, takes a process approach. He consistently finds interactions between leader-member relations, task structure, leader power, and leader's least preferred co-worker (LPC) rating. Fielder's research, in addition, takes place both in the lab and field, across cultures, and in many leader-member settings. His ideas have generated considerable research activity (Hill 57, Fishbein, Landy & Hatch 38, Shima 109, Katzel et al 66). Two studies even returned to the trait approach in hunting for personality correlates for least preferred co-worker ratings; Jacoby (61) correlated high LPC with creativity, and Mitchell (86, 87) reported a positive correlation between LPC and cognitive complexity.

Fiedler, however, has not escaped from criticism. Graen and co-workers, (48) in a careful, critical review of the contingency model, noted a number of methodological and statistical problems. Fiedler's procedure, according to Graen et al, involves partitioning and assigning weights to variables in such a way as to support the model. The model then becomes less sensitive to other relevant variables and disconfirming results.

Research on leadership style in the Lewin and the Lippit & White (75) tradition has been sparse in the last 5 years. One cross-cultural study by Meade (83) employed the same procedure as Lippit & White. Hindu boys were found to have higher morale with authoritarian leaders than with democratic leaders. A study by MacDonald (77) indicated that a dominant leader induced quicker behavior modification of delinquency acts with Job Corpsmen, but a more democratic style concerned with group demands superseded dominancy in delinquency reduction when measured later.

Leadership research, more than other areas of group dynamics, seems to have suffered in the laboratory. Among the more commonly encountered problem areas are: (*a*) leaders often have control over important resources which motivate joining and remaining in groups; (*b*) the relationship between leader and followers is longitudinal—it takes time for group goals, leader abilities, and situational variables to synchronize into a working relationship; (*c*) most leadership situations are in the context of one or more larger organizations which impose demands and restrictions on leader-member relationships. The above considerations lie outside the normal laboratory settings of short duration, arbitrarily assigned leaders, and little leader power. The dynamics found in the field are necessary for a full conceptual understanding of leadership.

ENVIRONMENTAL PSYCHOLOGY

Five years ago Gerard & Miller discussed animal studies of dominance as a subheading under power structure, which was itself a subheading under structural characteristics of groups. This initial concern with territoriality and dominance, in humans and other animals, has both broadened and grown sufficiently so that today it seems reasonable to talk of an area termed environmental psychology. Like many new fields, it has emerged in the interstices between more traditional ones: ethologists, anthropologists, psychologists, architects, and planners have grouped studies around a common concern with how the environment shapes and is shaped by behavior. Since the bulk of these studies involve group behavior, it seems appropriate to recognize the field here.

New fields are often first heralded in popular books and conference proceedings. Certainly Robert Somner's *Personal Space: The Behavioral Basis of Design* (112) and Edward T. Hall's *The Hidden Dimension* (51) are undergraduate best sellers. And both authors contributed to the International Symposium on The Use of Space by Animals and Men. The papers from this symposium have been edited by A. H. Esser and are published as *Behavior and Environment: The Use of Space by Animals and Men* (34). While there is much of interest here, the student of group dynamics will likely find Irwin Altman's (3) contribution of special interest. Altman and his colleagues have been concerned with environmental psychology far longer than most; thus his statement here, distilling much of their work, is both welcome and wise. Architects occasionally have a tendency to see design as the sole determinant of behavior; Altman, on the other hand, views environment as both an independent and dependent variable, one that not only affects and constrains but also serves as a medium of response and communication.

Social Psychology was the title of two books published in 1908. Thus, a common argument runs, the field was established in that year. By an analogous argument, environmental psychology could be dated from 1970, for that is the date of publication of *Environmental Psychology: Man and His Physical Setting*, edited by Proshansky, Ittleson & Rivlin (98). This handsome book contains 65 articles, with over 750 references in the author index. It is a fine first stop for anyone who wonders what environmental psychology has been about so far.

ENCOUNTER GROUPS

Equaling concern with the nature of environmental effects on behavior is a burgeoning interest in interpersonal communication and understanding. Certainly the area of small group endeavor which has generated the greatest affect and controversy is the Encounter Group or Sensitivity Training movement. The movement has exposed a large number of people, lay and professional, to a direct examination of the psychological processes occurring in groups and has received much publicity in both the public media and the journals. The process of sensitivity training or T-grouping has attracted both strong advocates and severe critics among psychologists. Carl Rogers (103), for example, presents a strong case for the potential benefits for participants in encounter groups, while Sigmund Koch (69) paints a dark picture of the threats to human dignity and personal worth inherent in the course of encounter. Other discussions of the theory and practice of sensitivity training can be found in Egan (33), Lakin (70), and Aronson (7). Egan has also edited a useful collection of basic readings (32).

Whether advocates or opponents of sensitivity training, discussants agree that the experience itself has high impact and arouses strong affect in participants. Disagreement centers on (*a*) the exact processes which occur in groups; (*b*) the effects of trainer style and actions; and (*c*) the long-term effects of the experience (or whether there are long-term effects). The problem facing the evaluator is not an absence of research reports but an absence of quality in research. Campbell & Dunnette (20) give an excellent review of the methodological and statistical limitations which seem endemic to studies of T-groups. Among the more serious difficulties are inadequate (or totally absent) control groups, unwarranted causal inferences from correlational data, and reliance on subjective self-report or possibly biased ratings by peers, subordinates, or supervisors.

We should hasten to note that the problems with research in this area are not a function of the competence of the investigators but rather reflect the almost insurmountable methodological and ethical obstracles inherent in the situation. Controlled experiments involving deception and manipulation of outcomes or interactions, which could answer many vital questions, would be ethically questionable at best, and could represent an unwarranted infringement of individual freedom and privacy with potentially disastrous results. Within correlational designs, choosing appropriate control groups, defining meaningful and valid outcome criteria, developing valid and objective categories of in-group behavior, obtaining a sufficient N, and assessing the generality of findings all contribute to making the researcher's lot an unhappy one. Morton Lakin (70) provides an insightful and sympathetic discussion of these and other pitfalls facing the student of encounter groups.

The research picture is not totally bleak, however. The awareness and discussion of problems inherent in T-group research seem to be resulting in more innovative approaches. For example, Marvin Dunnette (20), who has provided much of the best methodological criticism of T-group research and who could only be described as a skeptic, found, in a well-designed study using multiple trainers and groups, that T-groups do indeed tend to increase empathy and interpersonal understanding. In other studies, Tart (118) and Shapiro & Diamond (107) report significant increases in hypnotic susceptibility as a result of T-group training. These latter results represent the use of a relatively well validated measure to indicate changes in basic trust.

There seems to be reason for hope that the next few years will produce enough valid data to enable a more accurate evaluation of T-group effects. In particular, if some consensus can be reached on criteria for assessing the effects of training, it may be possible to accumulate a sufficient archive of data to enable investigators to make stronger statements and to generalize findings. One of the most promising lines of research would seem to be the application of techniques of systematic observation to the study of group process. Such studies should lead to the uncovering of causal relationships in the multivariate group environment. Here in particular the application of path analysis and crosslag correlations to longitudinal data from groups should be invaluable. In any event, this area will undoubtedly receive a sizable proportion of the research energy available in the near future.

POSTSCRIPT

Summarizing the research reviewed (or not reviewed) in an area as diverse and loosely linked as the study of small groups is a practical and theoretical impossibility. Let us close instead with a few predictions of the directions research may take in the next few years (predictions which may be handily disconfirmed in the next assessment of the area).

It seems likely that increased emphasis will be placed on studies of *processes* within groups and on the interactions of multiple situational and individual variables over time. Given the proliferation of variables determined to influence individual and group behavior and the often conflicting results generated by studies examining only one or a few aspects of group behavior, more and more investigators may be motivated to turn to multivariate, longitudinal research. Such a shift in approach may bring more unity to the area of attraction, new life to the study of leadership, and more understanding of the complexities of interpersonal communication and influence. Further, it seems likely that variables regarded as both relevant and admissable in the study of group processes will continue their drift in a cognitive direction. Much S-R vocabulary remains in evidence of course. Still, a drive to reassert cognitive models and to accept cognitive phenomena as worthy of study is quite discernable.

Much future research is likely to be nonexperimental, involving the systematic study of natural groups over time. This does not imply that we feel that laboratory investigations will die out or become moribund, but rather that there will be a realization of the limitations of the laboratory in providing complete information about long-duration, complex interactions from brief investigations of highly restricted subject populations. Hopefully, researchers will achieve competence in utilizing both laboratory and field techniques in coordination to bring order or at least understanding to a multivariate universe.

LITERATURE CITED

1. Allport, H. 1924. *Social Psychology*. Boston: Houghton Mifflin
2. Altman, I. 1966. Aspects of the criterion problem in small group research: II. The analysis of group tasks. *Acta Psychol.* 25:199–221
3. Altman, I. 1971. Ecological aspects of interpersonal functioning. See Ref. 34
4. Argyle, M. 1970. Eye-contact and distance: A reply to Stephenson and Rutter. *Brit. J. Psychol.* 61: 395–96
5. Argyle, M., Dean, J. 1965. Eye contact, distance and affiliation. *Sociometry* 28:289–304
6. Aronson, E. 1969. Some antecedents of interpersonal attraction. *Nebraska Symposium on Motivation*, ed. W. Arnold, S. Levine, 143–71. Lincoln: Univ. Nebraska Press
7. Aronson, E. 1972. *The Social Animal*. New York: Freeman
8. Aronson, E., Linder, D. 1965. Gain and loss of esteem as determinants of interpersonal attractiveness. *J. Exp. Soc. Psychol.* 1:156–71
9. Aronson, E., Willerman, B., Floyd, J. 1966. The effect of a pratfall on increasing interpersonal attractiveness. *Psychon. Sci.* 4:227–28
10. Baron, R. S., Dion, K. L., Baron, P., Miller, N. 1970. *Group norms, elicited values and risk taking*. Unpublished manuscript, Univ. Minnesota
11. Barry, H., Child, I., Bacon, M. 1959. Relation of child training to subsistence economy. *Am. Anthropol.* 61:51–63
12. Bateson, N. 1966. Familiarization, group discussion, and risk taking. *J. Exp. Soc. Psychol.* 2:119–29
13. Berry, J. W. 1967. Independence and conformity in subsistence-level societies. *J. Pers. Soc. Psychol.* 7:415–18
14. Berscheid, E., Walster, E. H. 1969. *Interpersonal Attraction*. Reading, Mass.: Addison-Wesley
15. Blalock, H. M. Jr. 1961. *Causal In-*

ferences in Non-experimental Research. Chapel Hill: Univ. North Carolina Press
16. Blalock, H. M., Blalock, A. B., Eds. 1968. *Methodology in Social Research.* New York: McGraw-Hill
17. Brown, R. 1965. *Social Psychology.* New York: Free Press
18. Byrne, D., Lamberth, J. 1971. Cognitive reinforcement theories as complementary approaches to the study of attraction. See Ref. 90, 59–84
19. Byrne, D., Lamberth, J., Palmer, J., London, O. 1969. Sequential effects as a function of explicit and implicit interpolated attraction responses. *J. Pers. Soc. Psychol.* 13:70–78
20. Campbell, J. P., Dunnette, M. D. 1968. Effectiveness of T-group experiences in managerial training and development. *Psychol. Bull.* 70:73–104
21. Cartwright, D., Zander, A. 1960. *Group Dynamics.* New York: Harper & Row. 2nd ed.
22. Collins, B. E., Guetzkow, H. A. 1964. *Social Psychology of Group Processes for Decision-making.* New York: Wiley
23. Collins, B. E., Raven, B. H. 1968. Group structure: Attraction, coalitions, communication, and power. See Ref. 73, 4:102–85
24. Cottrell, N. B. 1968. Performance in the presence of other human beings: Mere presence, audience, and affiliation effects. *Social Facilitation and Imitative Behavior,* ed. E. C. Simmel, R. A. Hoppe, G. A. Milton, 185–236. Boston: Allyn & Bacon
25. Cottrell, N. B. 1972. Social facilitation. See Ref. 82, 185–231
26. Cottrell, N. B., Rittle, R. H., Wack, D. L. 1967. The presence of an audience and list type as joint determinants of performance in paired-associate learning. *J. Pers.* 35:425–34
27. Cottrell, N. B., Rittle, R. H., Wack, D. L. 1968. Social facilitation of dominant responses by the presence of an audience and the mere presence of others. *J. Pers. Soc. Psychol.* 9:245–50
28. Dabbs, J. M. Jr. 1969. Similarity of gestures and interpersonal influence. *Proc. 77th Ann. Conv. APA* 4:337–38
29. Darley, J., Latané, B. 1970. *Bystander Intervention.* New York: Appleton-Century-Croft
30. Dion, K. L., Baron, R., Miller, N. 1970. Why do groups make riskier decisions than individuals? *Advances in Experimental Social Psychology,* ed. L. Berkowitz, 5:305–77. New York: Academic
31. Dion, K. L., Miller, N., Magnan, M. A. 1970. Cohesiveness and social responsibility as determinants of group risk taking. *Proc. 78th Ann. Conv. APA* 5:335–36
32. Egan, G. 1971. *Encounter Groups: Basic Readings.* Belmont, Ca.: Brooks/Cole
33. Egan, G. 1970. *Encounter: Group Processes for Interpersonal Growth.* Belmont, Ca.: Brooks/Cole
34. Esser, A. H., Ed. 1971. *Behavior and Environment: The Use of Space by Animals and Man.* New York: Plenum
35. Ettinger, R. F., Nowicki, S. Jr., Nelson, D. A. 1970. Interpersonal attraction and the approval motive. *J. Exp. Res. Pers.* 4:95–99
36. Fast, J. 1971. *Body Language.* New York: Pocket Books
37. Fiedler, F. E. 1967. *A Theory of Leadership Effectiveness.* New York: McGraw-Hill
38. Fishbein, M., Landy, E., Hatch, G. 1969. A consideration of two assumptions underlying Fiedler's contingency model for prediction of leadership effectiveness. *Am. J. Psychol.* 82:457–73
39. Fishbein, M., Landy, E., Hatch, G. 1969. Some determinants of an individual's esteem for his least preferred co-worker: An attitudinal analysis. *Hum. Relat.* 22:173–88
40. Flanders, J. P., Thistlethwaite, D. L. 1967. Effects of familiarization and group discussion upon risk taking. *J. Pers. Soc. Psychol.* 5:91–97
41. Frager, R. 1970. Conformity and anticonformity in Japan. *J. Pers. Soc. Psychol.* 15:203–10
42. Friedlander, F. 1966. Performance interactional dimensions of organizational work groups. *J. Appl. Psychol.* 50:257–65
43. Gallo, P. S., McClintock, C. G. 1965. Cooperative and competitive behavior in mixed-motive games. *J. Confl. Resolut.* 9:68–78
44. Gerard, H. B., Miller, N. 1967. Group dynamics. *Ann. Rev. Psychol.* 18: 287–332

45. Gibb, C. A. 1968. Leadership. See Ref. 73, 4:205–73
46. Goffman, E. 1971. *Relations in Public: Microstudies of the Public Order.* New York: Basic Books
47. Goldberg, G. N., Kiesler, C. A., Collins, B. E. 1969. Visual behavior and face-to-face distance during interaction. *Sociometry* 32: 43–53
48. Graen, G., Alvares, K., Orris, J. B., Martella, J. A. 1970. Contingency model of leadership effectiveness: Antecedent and evidential results. *Psychol. Bull.* 74:285–96
49. Griffitt, W. B. 1969. Personality similarity and self-concept as determinants of interpersonal attraction. *J. Soc. Psychol.* 78:137–46
50. Hackman, J. R. 1968. Effects of task characteristics on group products. *J. Exp. Soc. Psychol.* 4:162–87
51. Hall, E. T. 1966. *The Hidden Dimension.* New York: Doubleday
52. Hauser, R. M., Goldberger, A. S. 1971. The treatment of unobservable variables in path analysis. *Sociological Methodology,* ed. H. L. Costner, 81–117. San Francisco: Jossey-Bass
53. Heider, F. 1968. *The Psychology of Interpersonal Relations.* New York: Wiley
54. Heise, D. R. 1969. Problems in path analysis and causal inference. *Sociol. Methodol.* 1:38–73
55. Helmreich, R. 1971. The TEKTITE 2 human behavior program. *J. Suppl. Abstr. Serv.*, p. 13
56. Henchy, T., Glass, D. C. 1968. Evaluation apprehension and the social facilitation of dominant and subordinate responses. *J. Pers. Soc. Psychol.* 10:446–54
57. Hill, W. 1969. A situational approach to leadership effectiveness. *J. Appl. Psychol.* 53:513–17
58. Hinds, W. C. 1962. *Individual and group decisions in gambling situations.* Unpublished master's thesis. Mass. Inst. Technol.
59. Hollander, E. P., Julian, J. W. 1969. Contemporary trends in the analysis of leadership processes. *Psychol. Bull.* 71:387–97
60. Homans, G. 1971. Attraction and power. See Ref. 90, 46–58
61. Jacoby, J. 1968. Creative ability of task-oriented versus person-oriented leaders. *J. Creative Behav.* 2:249–53
62. Jaffee, C. L. 1968. Leadership attempting: Why and when? *Psychol. Rep.* 23:939–46
63. Jaffee, C. L., Lucas, R. L. 1969. Effects of rates of talking and correctness of decisions on leader choice in small groups. *J. Soc. Psychol.* 79:247–54
64. Janis, I. *Victims of Groupthink: A Psychological Analysis of Foreign Policy Decisions and Fiascos.* New York: Harcourt, Brace, Jovanovich. In press
65. Katz, D. 1972. Some final considerations about experimentation in social psychology. See Ref. 82, 549–61
66. Katzell, R. A., Miller, C. E., Rotter, N. G., Venet, T. G. 1970. Effects of leadership and other inputs on group processes and outputs. *J. Soc. Psychol.* 80:157–69
67. Kelley, H. H., Thibaut, J. W. 1968. Group problem solving. See Ref. 73, 4:1–88
68. Kiesler, C. A., Goldberg, G. N. Multi-dimensional approach to the experimental study of interpersonal attraction: Effect of a blunder on the attractiveness of a competent other. *Psychol. Rep.* 22:693–705
69. Koch, S. 1969. Stimulus/Response—"Psychology Cannot be a Coherent Science." *Psychol. Today* Sept.: 68
70. Lakin, M. 1972. *Interpersonal Encounter: Theory and Practice in Sensitivity Training.* New York: McGraw-Hill
71. Land, K. C. 1969. Principles of path analysis. *Sociological Methodology,* ed. E. F. Borgatta, 3–37. San Francisco: Jossey-Bass
72. Levinger, G., Schneider, D. J. 1967. Test of the "Risk is a value" hypothesis. *J. Pers. Soc. Psychol.* 6:467–71
73. Lindzey, G., Aronson, E., Eds. 1968. *Handbook of Social Psychology.* Reading, Mass.: Addison-Wesley. 2nd ed. 5 vols.
74. Lindzey, G., Byrne, D. 1968. Measurement of social choice and interpersonal attractiveness. See Ref. 73, 2:452–510
75. Lippitt, R., White, R. K. 1943. The "social climate" of children's groups. *Child Behavior and Development,* ed. R. G. Barker, J. S. Koumin, H. F. Wright, 485–508. New York: McGraw-Hill
76. Lyons, M. 1971. Technique for using

ordinal measures in regression and path analysis. See Ref. 52, 147–74

77. MacDonald, W. S. 1967. Social structure and behavior modification in Job Corps training. *Percept. Mot. Skills* 24:142
78. Madaras, G. R., Bem, D. J. 1968. Risk and conservatism in group decision-making. *J. Exp. Soc. Psychol.* 4:350–65
79. Marquis, D. G. 1962. Individual responsibility and group decisions involving risk. *Ind. Manage. Rev.* 3:8–23
80. Marsden, E. N. 1966. Values as determinants of friendship choice. *Conn. Coll. Psychol. J.* 3:3–13
81. Matlin, M. W., Zajonc, R. B. 1968. Social facilitation of word associations. *J. Pers. Soc. Psychol.* 10:455–60
82. McClintock, C. G., Ed. 1972. *Experimental Social Psychology.* New York: Holt, Rinehart, Winston
83. Meade, R. D. 1967. An experimental study of leadership in India. *J. Soc. Psychol.* 72:35–43
84. Mehrabian, A. 1968. Relationship of attitude to seated posture, orientation, and distance. *J. Pers. Soc. Psychol.* 10:26–30
85. Milgram, S. 1963. Behavioral study of obedience. *J. Abnorm. Soc. Psychol.* 67:371–78
86. Mitchell, T. R. 1970. The construct validity of three dimensions of leadership research. *J. Soc. Psychol.* 80:89–94
87. Mitchell, T. R. 1970. Leader complexity and leadership style. *J. Pers. Soc. Psychol.* 16:166–74
88. Morris, C. G. 1966. Task effects on group interaction. *J. Pers. Soc. Psychol.* 4:545–54
89. Murdock, G. P. 1949. *Social Structure.* New York: Macmillan
90. Murstein, B. I., Ed. 1971. *Theories of Attraction and Love.* New York: Springer
91. National Academy of Science 1972. *Human Factors in Long Duration Space-flight.* Washington: GPO
92. Naylor, J. C., Dickinson, T. L. 1969. Task structure, work structure, and team performance. *J. Appl. Psychol.* 53:167–77
93. Newcombe, T. 1971. Dyadic balance as a source of clues about interpersonal attraction. See Ref. 90, 31–45
94. O'Brien, G. E., Owens, A. G. 1968. Member intelligence and group productivity. *Aust. Mil. Forces Res. Rep. 6-68.* 14 pp.
95. Oskamp, S. 1971. Effects of programmed strategies on cooperation in the prisoner's dilemma and other mixed-motive games. *Cooperation and Exploitation in Mixed-motive Games*, ed. L. S. Wrightsman, J. O'Connor, N. J. Baker. Belmont, Ca.: Brooks/Cole
96. Paulus, P. B., Murdock, P. 1971. Anticipated evaluation and audience presence in the enhancement of dominant responses. *J. Exp. Soc. Psychol.* 7:280–91
97. Pilkonis, P. A., Zanna, M. P. 1969. *The choice-shift phenomenon in groups: Replication and exclusion.* Unpublished manuscript, Yale Univ.
98. Proshansky, H. M., Ittelson, W. H., Rivlin, L. G., Eds. 1970. *Environmental Psychology: Man and his Physical Setting.* New York: Holt, Rinehart, Winston
99. Pruitt, D. G., Teger, A. I. 1969. The risky shift in group betting. *J. Soc. Psychol.* 5:115–26
100. Radloff, R., Helmreich, R. 1968. *Groups Under Stress: Psychological Research in SEALAB II.* New York: Appleton-Century-Crofts
101. Reagor, P. A., Clore, G. L. 1970. Attraction, test anxiety, and similarity-dissimilarity of test performance. *Psychon. Sci.* 18:219–20
102. Reiss, A. J. Jr. 1971. Systematic observation of natural social phenomena. See Ref. 52
103. Rogers, C. 1969. The group comes of age. *Psychology Today* Dec., p. 58
104. Rosenblood, L. K., Goldstein, J. H. 1969. Similarity, intelligence, and affiliation. *Proc. 77th Ann. Conv. APA* 4:341–42
105. Rubin, Z. 1970. Measurement of romantic love. *J. Pers. Soc. Psychol.* 16:265–73
106. Schachter, S. 1964. The interaction of cognitive and physiological determinates of emotional state. See Ref. 30, 1:49–80
107. Shapiro, J. L., Diamond, M. J. 1972. Increases in hypnotizability as a function of encounter group training: Some confirming evidence. *J. Abnorm. Psychol.* 79:112–15
108. Secord, P. F., Backman, C. W. 1964. *Social Psychology.* New York: McGraw-Hill
109. Shima, H. 1968. The relationship be-

tween the leader's modes of interpersonal cognition and the performance of the group. *Jap. Psychol. Res.* 10:13–30

110. Sigall, H., Aronson, E. 1967. Opinion change and the gain–loss model of interpersonal attraction. *J. Exp. Soc. Psychol.* 3:178–88
111. Ibid 1969. Liking for an evaluator as a function of her physical attractiveness and nature of the evaluations. 5:93–100
112. Somner, R. 1969. *Personal Space: The Behavioral Basis of Design.* Englewood Cliffs, N. J.: Prentice-Hall
113. Speer, A. 1971. *Inside the Third Reich.* New York: Avon
114. Stass, J. W., Willis, F. N. Jr. 1967. Eye contact, pupil dilation, and personal preference. *Psychon. Sci.* 7:375–76
115. Stephenson, G. M., Rutter, D. R. 1970. Eye-contact, distance and affiliation: A re-evaluation. *Brit. J. Psychol.* 61:385–93
116. Strodtbeck, F. L. 1964. Considerations of meta-method in cross-cultural studies. *Am. Anthropol.* 66: 223–29
117. Tagiuri, R. 1968. Person perception. See Ref. 73, 3:395–435
118. Tart, C. T. 1970. Increases in hypnotizability resulting from a prolonged program for enhancing personal growth. *J. Abnorm. Psychol.* 75:260–66
119. Tolman, C. W. 1968. The varieties of social stimulation in the feeding behavior of domestic chicks. *Behavior* 30:275–86b
120. Tuckman, B. W. 1967. Group composition and group performance of structured and unstructured tasks *J. Exp. Soc. Psychol.* 3:25–40
121. Vidmar, N. 1970. Group composition and the risky shift. *J. Exp. Soc. Psychol.* 6:153–66
122. Von Neumann, J., Morgenstern, O. 1944. *Theory of Games and Economic Behavior.* New York: Wiley
123. Wallach, M. A., Kogan, N., Bem, D. J. 1964. Diffusion of responsibility and level of risk taking in groups. *J. Abnorm. Soc. Psychol.* 68:263–74
124. Wallach, M. A., Kogan, N., Burt, R. 1968. Are risk takers more persuasive than conservatives in group discussion? *J. Exp. Soc. Psychol.* 4:76–87
125. Wallach, M. A., Wing, C. W. Jr. 1968. Is risk a value? *J. Pers. Soc. Psychol.* 9:101–6
126. Walster, E. 1971. Passionate love. See Ref. 90, 85–99
127. Ward, C. D. 1968. Seating arrangement and leadership emergence in small discussion groups. *J. Soc. Psychol.* 74:83–90
128. Weick, K. 1968. Systematic observational methods. See Ref. 73, 357–437
129. White, J. H., Hegarty, J. R., Beasley, N. A. Eye contact and observer bias: A research note. *Brit. J. Psychol.* 61:271–73
130. Whyte, W. H. Jr. 1964. *The Organization Man.* New York: Ronald
131. Willems, E. P. 1969. Risk is a value. *Psychol. Rep.* 24:81–82
132. Willis, R. H., Hollander, E. P. 1964. An experimental study of three response modes in social influence situations. *J. Abnorm. Soc. Psychol.* 69:150–56
133. Worchel, P., Schuster, S. D. 1966. Attraction as a function of the drive state. *J. Exp. Res. Pers.* 1:277–81
134. Wrightsman, L. S., O'Connor, J., Baker, N. J., Eds. 1972. *Cooperation and Competition: Readings on Mixed Motive Games.* Belmont, Ca.: Brooks/Cole
135. Zajonc, R. B. 1965. Social facilitation. *Science* 149:269–74
136. Zajonc, R. B. 1966. *Social Psychology: An Experimental Approach.* Belmont, Ca.: Wadsworth
137. Zajonc, R. B., Heingartner, A., Herman, E. 1969. Social enhancement and impairment of performance in the cockroach. *J. Pers. Soc. Psychol.* 13:83–92
138. Zajonc, R. B., Wolosin, R. J., Wolosin, M. A., Loh, W. D. 1970. Social facilitation and imitation in risk taking. *J. Exp. Soc. Psychol.* 6:26–46
139. Zimbardo, P. G. The pathology of imprisonment. *Social Psychology in the World Today*, ed. E. Aronson, R. Helmreich. New York: Van Nostrand. In press

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PSYCHOLOGY AND CULTURE

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It has long been known that human behavior is a function of characteristics of both the physical and the psychological environments. Koffka (108), for instance, distinguished between the geographical and the behavioral environment. The behavioral depends on the geographical; behavior depends on both. The geographical environment consists of both physical and man-made parts. Culture has been defined by some anthropologists (e.g. 88) as the man-made part of the human environment.[2] Thus, if we are to understand the determinants of behavior, we need to understand how culture influences it. In spite of the obvious importance of cultural variables in the determination of human behavior, this is the first time that the *Annual Review of Psychology* has examined the literature which connects psychology and culture.

Aspects of this area have been reviewed elsewhere (36, 50, 51, 62, 92, 97, 160, 163, 181). Several books of readings (2, 21, 113, 140) have sampled the field.

RATIONALE FOR CROSS-CULTURAL STUDIES

Cross-cultural research may be conducted for a variety of reasons: to check the generality of psychological laws; to increase the range of our observations on variables of interest; to determine the variations found in subjective culture variables in different settings; to take advantage of natural experiments involving combinations of variables that cannot be obtained in the laboratory; to study the manifestation of psychological variables in different cultural contexts; and to study cultures for their own sake (105, 174). Such research can serendipidously lead to new insights (31) about psychological principles and to laboratory studies to check these insights (e.g. 50).

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[1] Preparation of this review was supported in part by Social and Rehabilitation Service Grant 15-P-55175/5, Department of Health, Education, and Welfare. The review of the literature stopped on February 1, 1972, and unfortunately some of the 1971 periodicals did not reach us by that date. Due to limitations of space we refer to only about one quarter of the relevant literature. A review with better coverage of the literature was published by Triandis, Malpass & Davidson (170). We wish to thank Martin Fishbein and Richard Brislin, who made helpful comments on an earlier draft.

[2] The human environment is not the same as the behavioral or the geographical. When we refer to culture we consider the human environment in the broadest terms so that it includes every aspect of man's ecology. The behavioral and geographic environments are relevant to individuals; e.g. a person walking the streets of New York has only those streets as his geographic environment.

To put it another way, one assumption of much psychological work is that the processes under study are invariant across time and place. This assumption is being challenged by cross-cultural psychologists and the challenge seems valid (117). Cultural factors often require that we qualify our theories. For example, the developmental theory of Piaget may have to be modified to account for "regressions" which appear to occur because members of certain cultures acquire certain magical beliefs. Specifically, Heron (87) showed that Zambian children displayed a wide range of individual differences in locally developed psychometric instruments that predicted school achievement; yet children that demonstrated weight conservation did not differ on these valid tests from children not demonstrating this ability. Apparently even highly intelligent children, who perform well in school, are unable to solve Piaget-type problems due to the interference of magical beliefs. One way to respond to such data is to argue that the stages of cognitive development are invariant across settings but they are incorrectly tapped by the particular tests. Another way is to broaden the theory to make it capable of accounting for such findings.

METHODOLOGICAL PROBLEMS

We will here note only a few of the major methodological problems of cross-cultural research; more extensive discussions can be found in (18, 122, 141, 142, 170). The methodological difficulties of cross-cultural research are numerous (129, 170, 174). Two major types of such research can be distinguished: (*a*) studies which attempt to determine the generality of a psychological law, or the universality of a phenomenon; and (*b*) studies showing differences in laws or phenomena between societies. The former type of study is no more difficult than ordinary within-culture research; the latter type is much more difficult than ordinary research. Specifically, if one obtains similarities across cultures in spite of differences of language, instrument administration, etc, the phenomenon must be reasonably robust, but to establish that there is a difference in either the law or the phenomenon one must exclude a myriad of rival hypotheses which could account for the observed differences. In experimental work the random assignment of subjects to experimental conditions eliminates most of these rival hypotheses; in cross-cultural work random assignment is usually meaningless. Thus, if the abilities of two racial groups are compared, for instance, there are innumerable rival hypotheses concerning differences in performance which have little to do with the level of abilities per se, e.g. differences in motivation, experimenter biases, anxiety-ability interaction, comprehension of instructions, familiarity with test materials, differential reliability and validity, response sets, etc. Most studies comparing abilities across racial groups are methodologically so poor that they should not have been published. Yet not only have they been published in large numbers, but they have even been uncritically and favorably reviewed (e.g. 99) and employed as a basis for public policy. Labov (111), in a sound and devastating criticism of minority testing, presents data which suggest that motivational factors account for most of the observed differences in test performance. Sherwood & Nataupsky (151) showed that the conclusions of investigators in this area can be predicted from seven biographical items! This unfortunate state of affairs must be corrected within psychology before pressures from the outside make all cross-cultural work impossible.

Another distinction is that between *etic* and *emic* studies (18, 139). The *emic* approach attempts to obtain the best possible description of a phenomenon occurring in a particular culture, utilizing concepts employed only in that culture. It is the most accurate description of the phenomenon. However, *emic* data cannot be compared across cultures, because by definition the concepts developed in a single culture may not be universal. The *etic* approach studies a phenomenon by utilizing universal concepts. Such concepts are often approximations of emic concepts, but being universal they are suitable for comparative work. A major problem with much cross-cultural psychological work is that it utilizes a *pseudoetic* approach, i.e. emic measures (usually made in the USA) are assumed to be etic. Instruments based on American theories and items reflecting American conditions are simply translated and used in other cultures. Translation is a very difficult problem and requires special solutions (23, 179). The emphasis on *decentering* of concepts is particularly valuable in this context. Beyond the problems of translation, when measurements are applied outside of the population in which they were developed, mean differences between cultural groups are essentially uninterpretable in the absence of demonstrations of similarity (29).

Such similarity can be demonstrated in different ways. First, it is possible to follow exactly the same procedures in each culture and develop different measures appropriate for each culture and show similar patterns of correlation among scores on a given instrument and other variables in the several cultures. Similar construct validity can be a convincing argument of demonstrated similarity in the meaning of the measures. More specifically, if a variable is related to several other variables in the same way in two cultures, and to just one variable in a very different way in the two cultures, we can consider that the latter variable provides us with data on a cultural difference. Or, if there is a strong pattern of similarity among some variables, but there are cultural differences in the levels of these variables, again we have reasons to believe the observed differences. For example, if ability and school performance measures show similar patterns of correlation, and there is a difference in the level of both the ability and performance measures for two cultural groups, we may conclude that there is a difference between the two groups. Second, a variety of experimental manipulations might be introduced which result in the cultural groups behaving in a similar fashion. Then it is possible to specify what needs to be done to "equate" the performance of two cultural groups. This approach (see 39, 40) has strength in that it makes the cultural differences describable in terms of the experimental operations that are needed to equate the performance of two groups.

The problem of use of inappropriate items is particularly critical in the area of ability tests. Wober (187) has convincingly argued that much of this work is centricultural (how do *they* do *our* tricks) instead of cross-cultural (how do *they* do *their* tricks). Irvine (93) has discussed well some of the problems of ability measurement in Africa.

Gordon & Kikuchi (79) emphasize the importance of etic measurement in the development of personality tests. They also point out that checks of relevance, acceptability of test items, meaningfulness of the test format and directions, and differential susceptibility to response sets should be performed on the items to be scaled in each culture before undertaking the major task of scale standardization. They also point to the need to examine the item factorial structure in each culture. Werner & Campbell (179) correctly point out that the item pool should be developed in both directions; Berrien (14) agrees, but Gordon (78), in his reply to Berrien, is unduly concerned about the presence of items which are culture specific. If these items are emic they will form their own factors; if they are etic they will form etic factors and increase the reliability of the measurement of these factors.

Several methods are helpful in the extraction of etic factors. Specifically, componential analysis (72, 76), facet analysis (68, 83), feature analysis (133), and factor analysis (131) may be employed to discover etic patterns in emic data. Multidimensional scaling results in emic data, but inspection of the factors may suggest similarities across cultures (178).

Culturally determined response sets such as a tendency toward acquiescence (86), a tendency to employ the middle of a scale (80, 189), or differential influences of the test format (85) further complicate cross-cultural research and require careful controls.

Another strand of cross-cultural studies utilized the so-called cross-cultural method developed by Whiting & Child (182). Using societies instead of individuals as the units of observation, the method relies on content analyses of reports assembled in the Human Relations Area File (HRAF). Naroll (128) reviewed studies that utilize this approach; Ford (71) published readings which criticize and advocate the use of these files. Several problems associated with such research have been discussed. For example, the kinds of samples drawn from the HRAF may influence the results, as was demonstrated by Chaney & Revilla (34). The observations are statistically nonindependent, due to cultural diffusion, but Smith & Crano (154) described a solution to this problem.

Guthrie (82) has shown that much caution is necessary when utilizing the cross-cultural method. While many of the correlations computed by Whiting & Child were consistent with their derivations from psychoanalytic theory, Guthrie showed that many other equally sizable and theoretically embarrassing correlations exist in the complete matrix of intercorrelations. Rohner & Katz (145) proposed more elaborate tests of interrater reliability and discriminant validity with such data.

CONCEPTUAL FRAMEWORK

Most of the data of human psychology consist of observations of some sort of human behavior. The task of psychologists is to discover relationships of variables from the (*a*) geographical environment (such as particular stimulus configurations) and/or (*b*) the social environment (such as characteristics or behaviors of the Other Person) with observations of individual behavior. To account for regularities in these relationships, psychologists have utilized hypothetical variables such as abilities, acquired behavioral dispositions such as attitudes (28), social structural determinants such as roles, and personality dispositions. Triandis et al (174) have discussed acquired behavioral dispositions that reflect social structural determinants under the rubric of "subjective culture"—a cultural group's characteristic way of perceiving its social environment. The latter includes attitudes, norms, roles, values, expectancies and other constructs.

Social structural influences can be considered from both the perspective of a particular social group and the individual subject. For example, members of groups prescribe what behaviors are appropriate for persons holding particular positions in such groups. Such *prescribed roles* are communicated only imperfectly to each role holder who develops *subjective roles* reflecting the prescribed roles; his *enacted roles* are imperfectly related to his subjective roles. Thus a distinction between social structural variables such as prescribed roles, subjective culture variables such as subjective roles, and behaviors consistent with the subjective culture variables is necessary to take into account the complexity of human behavior.

From these considerations it follows that six classes of variables need to be examined when relating culture and psychology, as demonstrated by the following equation:

$$B = f(A, SC, PD, E, SS, O) \qquad 1.$$

Equation 1 states that Behavior (B) is a function of the person's abilities (A), subjective culture (SC), and personality predispositions (PD). Some variance may also be traced to the physical environment (E), the social structure (SS), and the Other (O).

The six independent variables of Equation 1 are contemporaneous. However, in much of the literature we find historical E, SS, and O variables that act as independent variables for A, SC and PD variables. Thus, in some cases the historical variables are the distal independent variables, and the A, SC, and PD variables are the proximal independent variables that determine the observed behavior. In some studies both a historical and contemporaneous E variable may be employed, giving two sets of independent variables. For example, Segall, Campbell & Herskovits (148) assume the degree to which the environment has many right angles (a historical variable called carpenteredness) influences the person's predisposition to see the angles in the Müller-Lyer illusion as right angles (a contemporaneous predisposition which is a component of his ability to make perceptual judgments) so that the Müller-Lyer materials (contemporaneous E-variables) are responded to differently. Or, the mother's behavior over time (historical O-variable) influences the child's personality disposition, while the mother's contemporaneous behavior has an additional influence on the child's behavior.

Our overview of the literature suggests that in most studies E and O variables have historical meaning and SS variables contemporaneous meaning. When this is not the case we will qualify our references to E, SS, and O-variables to indicate that the infrequent version of the variable is employed in the particular study.

In the sections that follow we first list (Table 1) one or two studies that investigated each of the six independent variables of Equation 1 in cross-cultural perspective. This will give an overall view of the field. Second, we focus on the proximal independent variables of Ability, Subjective Culture, and Personality Predisposition. Within each section we classify studies according to the distal variables (E, SS, and O) which act as independent variables in studies in which the proximal variables (A, SC, PD) are the dependent variables. This approach will allow the reader to see what cells of the conceptual framework are over- and under-researched. Table 1 provides an Overview of Studies which have been done with the above variables as foci.

TABLE 1. Overview of Studies

A—*Person's Abilities*
- Intelligence, e.g. verbal, numerical, spacial abilities (93, 94, 187)
- Perceptual style (16, 186)
- Perceptual skills, e.g. pictorial depth (90)
- Susceptibility to illusions (148)
- Cross-cultural tests of models of information processing (166, 183)
- Thinking (40, 74)
- Cognitive development (70, 77, 81, 138)
- Moral development (24, 25, 162)
- Cognition (21)

SC—*Person's Subjective Culture*
- Meaning (131, 132, 134)
- Attitudes, e.g. toward modernization (47, 91)
- Intergroup attitudes (32, 67)
- Aesthetic judgments (37, 95, 96)
- Norms—appropriate behaviors, customs; social distance (22)
- Interpersonal distance (84, 115, 155)
- Subjective roles (69, 169, 173)
- Beliefs, stereotypes, categorization (coding of experience) (30, 61, 63, 124, 177)
- Studies of the relationship between attitudes and behavior (66, 167)
- Cross-cultural training (35, 64)
- Values (12, 13, 54, 106, 109, 168)

PD—*Personality Dispositions*
- Self-image in cross-cultural perspective (6)
- Anxiety—avoidance—stress (4, 114, 176)
- Authoritarianism (102)
- Alienation—suicide (7, 100, 101, 119)
- Conformity-adjustment to change (17, 73)
- Mental illness, psychopathology (3, 58, 116, 127)

E—*Physical Environment*
- Resources—types of economy (e.g. hunting, gathering, fishing, farming) (16, 17, 46, 47)
- Characteristics of (flat, mountainous, barren, carpentered, i.e. has high frequency of right angles) (148)
- Climate (118, 180)
- Physical distance—between people (9, 84); between tribes (22)

SS—*Social Structure*
- Social class—education, occupations, family background, income (91, 109)
- Prescribed roles—age, sex, race, family membership (125)
- Family organization—birth order, family structure (33, 125)
- Patterns of socialization (125, 137)
- Development—economic (22, 45–47, 50); cultural (educational) (91)

O—*Other Persons*

The same variables listed under A, SC, and PD can be applied to O, but also additional interpersonal variables or variables reflecting behavior in groups have been investigated, such as
- Recognition of emotion (59)
- Similarity of P and O (165, 175)
- Influence attempts and attitude change (184, 185)
- Leadership behaviors (123)
- Behaviors dividing resources among group members (104)
- Intergroup behavior (44, 52)
- Behaviors in game situations (104, 136)

ABILITIES

Environmental Antecedents of Perception

The major study in this area is by Segall, Campbell & Herskovits (148). They formed hypotheses based on Brunswick's concept of ecological cue validity (27) that predicted illusion susceptibility as a function of characteristics of the visual environment. They proposed, on the basis of an ecological cue validity theory, that persons living in "carpentered" environments, i.e. environments with extremely common occurrences of right angles, would be more susceptible to certain geometric illusions (e.g. the Müller-Lyer) than persons whose visual environment contains few carpentered objects. Likewise, persons exposed to overland vistas should be more susceptible to perspective illusions (e.g. horizontal-vertical; L or T) than persons without such experience. In general, they found that Western populations were more susceptible to the Müller-Lyer illusion, but less to the horizontal-vertical illusion than were non-Western (African) populations. Support was stronger for the former than for the latter. The strong form of the environmental hypothesis was not tested, as measurements on the environment were not employed in the study. The methodological and conceptual contributions of this research are considerable. The pattern of illusion susceptibility makes it "impossible to employ an all-encompassing explanation such as simpleness of mind, suggestibility, or educational level per se to account for their findings" (43). Partially because of this work the distinction between the operation of a mechanism or process as an antecedent of present perceptual performance and the development of such mechanisms is made more clearly here than in other areas of cross-cultural psychology. In this research strand, when developmental questions are pursued, the process by which the disposition developed results in the observed behavior is more carefully specified. This is perhaps because in the study of perception the methodology and explication of rival hypotheses is further advanced. Almost no one would now consider a study documenting a perceptual response difference between two populations without some relatively explicit discussion of the mechanisms which relate social structural differences to the perceptual response differences. By way of contrast, this sort of comparison—but usually without discussion of the mediation of differences—is by far the most popular category in cross-cultural work in socialization and personality.

For the perspective illusions the classes of variables called upon for explanation are environmental, determining the observer's cue utilization habits (148) which then influence illusion susceptibility. For the geometrical illusions, the person disposition is again a set of cue utilization habits, namely orthogonalization of angles, and derivative relative size judgments. The environmental variable in this latter case, carpenteredness of the environment, is man-made and is therefore potentially related to variables of social structure that either mediate the development of the disposition, or underlie both the disposition and the carpenteredness of the environment.

Environmental Antecedents of Social Structural Influences on Perception

There are many hypotheses concerning how increased susceptibility to the Müller-Lyer illusion, and the perceiving of three-dimensionality from two-dimensional displays, can arise from attributes of these social structural variables other than from the frequency with which the perceiver has seen carpentered objects.

One hypothesis is that education, modernization, and urbanization (all SS variables) increase the sophistication (42) of subjects, altering their attention or stimulus scanning habits (43), leading to greater accuracy in judgments. Since these SS variables are also antecedent to the E variable (carpenteredness) the two explanations of illusion susceptibility are confounded (20). Another hypothesis suggests that such variables as the strictness of the mother in socializing the child (46), or lack of ecological requirements for independence of judgment (50), cause the development of field dependence, which increases illusion susceptibility. In general, the generality of this effect across illusions remains yet untested. The ecological requirements of agricultural societies favor field dependence to a greater extent than do the requirements of hunting societies. This set of relationships has been extended to include nutritional antecedents of endocrinological syndromes which either (*a*) in conjunction with dispositions of the mother lead to harsher treatment of male children, and therefore greater field dependence (46), or (*b*) lead to greater field dependence through more direct endocrinological effects on cognitive/perceptual processes (50). This highly integrative approach, spanning classes of bio-social variables, seems an important one to develop further.

Another possibility, again confounding the carpentered world explanation (50, 98), is that illusion susceptibility is inversely associated with pigmentation of the fundus oculi, which decreases ability to detect contours. Berry (20) reports higher correlations of skin color with illusion susceptibility, when carpenteredness of the environment is partialled out, than of carpenteredness with skin color partialled. However, as Dawson (50) points out, both skin color and carpenteredness are confounded by variables such as modernity and urban residence. Jahoda's (98) evidence indicates that among less pigmented samples the effect is color specific, red figures eliciting greater susceptibility to the Müller-Lyer illusion than blue. Segall, Campbell & Herskovits (148) used partially red stimuli and did find the differences between Western (presumably less pigmented) and African samples reported above. This controversy has fallen into the trap of single method measurement (Müller-Lyer illusion) of the underlying disposition (susceptibility to geometric illusions). This is particularly unfortunate since those using the Segall, Campbell & Herskovits materials could have had data on other illusions which could shed light on the generality of the relation of skin pigmentation to illusion susceptibility, and thus its importance as a confound in the carpentered world hypothesis.

The final confounding explanation that should be ruled out before perceptual explanations are advanced is that the response is due to social factors affecting the response decisions, as distinct from the "percept" itself (170). The procedures of Segall et al adequately deal with this problem. Other psychophysical approaches toward the measurement and control of bias involve application of the Theory of Signal Detectability to recognition of faces of own and other race (121) and the ethnic identification of stimulus persons (56).

Social Structural Antecedents of Classification, Learning, Memory, and Thinking

A major study in this area is by Cole et al (40). Utilizing standard experimental psychological procedures, they explored the classification, learning, memory, and thinking behaviors of samples of Kpelle, from Liberia, varying in age and educational attainment. A strong sensitivity to cultural determinants of experimental results led the authors to adopt experimental materials that were particularly appropriate for the cultures studied. American children were sometimes tested with the Kpelle materials or according to the experimental procedures suggested by the Kpelle data. The data are complex and the authors are appropriately cautious. They conclude: "the cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another" (40, p. 233).

Ciborowski & Cole (38) showed that different problems can be more or less difficult in particular cultures, depending on the cultural context of problem solving. The structure of the problem is the most important determinant of problem solving level by a cultural group. The structure of the activity of the people under study must be matched with the experimental tasks.

SUBJECTIVE CULTURE

Social Structural Antecedents of Subjective Culture

Categorization.—Humans give identical responses (as perceived by an observer) to discriminably different stimuli. This phenomenon is called categorization. Earlier reviews of the literature (163) established that categorization is universal, but what is categorized varies from culture to culture. Extensive cross-cultural work has been done with color categories, primarily because it is possible to establish relationships between the physical character of the stimuli and the responses of the subjects. Much of this research is reviewed by Berlin & Kay (11), who also provide evidence in favor of the conclusion that there are semantic universals in color terminology and basic color terms are acquired in every culture in the same order. Although different languages encode in their vocabularies different numbers of basic color categories, there are exactly 11 basic categories from which the color terms of every language always draw.

The basic sequence is:

$$\begin{Bmatrix}\text{white}\\\text{black}\end{Bmatrix} \rightarrow \{\text{red}\} \rightarrow \begin{Bmatrix}\text{yellow}\\\text{or}\\\text{green}\end{Bmatrix} \begin{Bmatrix}\text{both}\\\text{yellow}\\+\\\text{green}\end{Bmatrix}$$

$$\rightarrow \{\text{blue}\} \rightarrow \{\text{brown}\} \rightarrow \begin{Bmatrix}\text{purple}\\\text{pink}\\\text{orange}\\\text{gray}\end{Bmatrix}$$

The authors show that all languages have terms for white and black, and if they have a third term it is red; if they have four terms it is yellow or green; if they have five it is both yellow and green, etc. They suggest that this is also the order of color term development in children.

Cognitive schemata.—Categories become associated with other categories, so that distinctive cognitive schemata can be observed. Members of different cultures utilize different schemata. For example, Shaffer, Sundberg & Tyler (150) showed that Indians emit more edibles when asked to "list 25 words that come to mind," while Dutch children emit more building parts and Americans more school, play, and action themes. Szalay (e.g. 157, 158) has developed an approach he calls "Associative Group Analysis" to study dominant cultural themes.

Rankings of importance of life concerns and life changes (144) show considerable similarity across cultures, allowing us to pay more attention to the few obtained cultural differences. Triandis et al (168) examined the perceived antecedents and consequents of 20 value terms in Japan, India, Greece, and the United States, and found both similarities and differences in the meaning of such value terms across cultures. For example, the perceived antecedents of SUCCESS include *high ability* and *patience* in all cultures, but Americans emphasize while Japanese de-emphasize *devotion* and *hard work* as antecedents of SUCCESS; all cultures see *joy*, *pride*, and *satisfaction* as consequences of SUCCESS, but while the Americans see *achievement* as an important consequence, the Greeks do not see such an outcome but instead emphasize that *love* follows SUCCESS. The Indians see *social distinction* and *vanity* as high probability outcomes of SUCCESS, while in the other cultures such connections are seen as improbable.

The appropriateness of the distance between two individuals in different kinds of social situations has been investigated by Little (115) in Europe and by Engebretson & Fullmer (60) in the orient. These studies confirm Hall's (84) argument that in "contact cultures" it is appropriate to touch in public situations, but in other cultures it is not appropriate to do so.

Stereotypes.—A particularly widely studied cognitive schema concerns the stereotypes of various ethnic groups. A most important paper by Campbell (30) provided theoretical underpinnings consistent with the empirical findings of Triandis & Vassiliou (171) and Vassiliou et al (177). A review by Triandis (167) suggests that stereotypes change with world events, with the amount of intergroup contact, and the type of contact. Developmental trends were traced by Lambert & Klineberg (112) and Ghiglione & Beauvois (75). Certain aspects of the total stereotype are valid, as shown by Schuman (147) and Abate & Berrien (1). Tajfel (159) presented a theory concerning the stereotyping process and some experiments which support it. Tajfel et al (161) showed that children are attracted by pictures that a majority of them perceive as belonging to their own national group. The correlation of liking and national assignment drops with age.

Affective meaning.—The largest cross-cultural study to date has been in progress since 1960 and will probably not be fully reported until 1980. Directed by Osgood (130–132, 134), it develops indigeneous (emic) semantic differentials in 25 locations around the globe. Factor analyses revealed an etic structure in these measurements. The study will result in an *Atlas of Affective Meaning* containing the mean evaluation, potency and activity (etic) scores, and several other statistics for about 500 words. The use of emic instruments which provide etic measurements is a major contribution of this study.

Behavioral intentions and role perceptions.—A monograph by Triandis, Vassiliou & Nassiakou (173) reports that four etic and several emic dimensions of behavioral intentions have been found in studies of Americans and Greeks. Association-Dissociation is relevant to interaction with ingroup vs outgroup members; Superordination-Subordination reflects differences in status; Intimacy-Formality reflects interpersonal familiarity; Hostility reflects competition among interacting members. Osgood (133) obtained similar etic factors using a different procedure. Role perceptions were also studied by Triandis et al (173) by examining the responses of Americans and Greeks to emically developed instruments. Again the same four dimensions of behavior emerged. Two-mode factor analysis permitted examination of the structure of roles as well as the structure of behavioral intentions. Roles are differentiated very clearly in Greece along the ingroup-outgroup dimension; such strong contrast is not obtained in the USA. This led to specific predictions of the behavior of American and Greek personnel directors when hiring employees recommended by a close friend or an unknown person. These predictions were supported by a highly significant interaction between culture and source of recommendation in Triandis & Vassiliou (172). Further studies (169) with data from 1800 respondents from five very different cultures suggest that each culture employs five or six emic behavior factors; inspection suggests that four of these are etic. In short, in every culture studied so far, emic factors such as Giving Love, Cooperation, Nurturance, and Lack of Hostility suggest the existence of an etic factor that might be called *Solidarity*. Other etic factors suggest *Denying of Status* (Control of the Other, Superordination) and *Intimacy* (kiss, pet, have sexual intercourse with). Finally, a mixture of Solidarity and Status appears in emic factors such as Formal Social Acceptance, Respect, and Submission. The etic dimensions suggest that we are here finding basic dimensions of social behavior which show both universality and phylogenetic continuity, since Solidarity and Status are the major dimensions of analysis employed by some animal social psychologists.

Intergroup attitudes.—Campbell & LeVine (32) examined some determinants of intergroup attitudes, while Brewer (22) used some of their data to predict the social distance among East African tribal groups. The more similar the perceived similarity of the outgroup the lower was the social distance; the nearer and the more economically developed the outgroup the lower the social distance; dissimilar groups that are advanced are more attractive than other advanced groups. Interpersonal similarity in religion, age, sex, and other characteristics leads to attraction (165), but similarity in status has a complex relationship to attraction (175).

Values.—Kohn (109) established important relationships between social class and preference for conformity versus independence in children. In both the United States and Italy upper middle-class parents stress independence and lower-class parents conformity. His theoretical analysis which relates demands of the job situation of the parents to child training and parental values is particularly interesting.

Two research programs by Berrien (12, 13) and Gordon (79, 80) have concentrated on the comparison of Japanese and American values with the Edwards and Gordon inventories, appropriately standardized. Berrien, Arkoff & Iwahara (15) explored the similarity in the values of parents and children of Japanese and American backgrounds, discovering a larger generational than a cultural gap.

Diaz-Guerrero (54) discussed the passive-active orientation as a sociocultural premise. He argues that Americans are characterized by active coping while Mexicans are passive copers. He sees definite implications for mental health and economic development in these differences in coping styles.

Modernization, acculturation, and social change.—An important literature has recently developed around these concepts. Modern man is seen as having a different subjective culture than traditional man. One controversy concerns the extent to which the modernization syndrome is to be contrasted with the traditional syndrome on a single dimension or on several dimensions. The work of Inkeles (91), Dawson (45, 47–50), Doob (55), and Kahl (103) utilizes a unidimensional conception of modernity. By contrast, Schnaiberg (146) and Wober (188) find it necessary to use a multidimensional conception which allows a person to be modern on one dimension and traditional on others. This is a controversy strongly reminescent of the Spearman-Thurstone controversies, and it is very likely that the multidimensionalists will win. On the one hand, the pioneering work of the unidimensionalists provides valuable insights; on the other hand, Stephenson (156) criticizes the pseudoetic methodology of much of the modernization literature.

Another research strand is focused around the work of McClelland (118), which attempts to demonstrate relationships between child-rearing patterns, human motives, and economic development. Pareek (135) proposed that economic development requires persons high in the need for achievement and extension and low in the need for dependence. Need for extension is characterized by concern for others. Need for dependence includes the need for guidance and direction by others and the need to avoid initiative or supplying leadership. McClelland & Winter (120) suggested that need for achievement can be changed and changes in need structure can become manifest in entrepreneurial activity. Singh (152, 153) also documented this relationship.

Methodological difficulties associated with McClelland's work (reliability of the TAT measures, sampling, confounding of variables, demand characteristics) make further research necessary before we can accept these conclusions.

Modernism can be measured, and certain antecedents such as the amount of education, socioeconomic status, and factory experience seem to be dependably associated with it. Certain kinds of child training methods are related to modernism. Much more needs to be learned, however, about both the multidimensional structure of modernism and its antecedents and consequences. Among the consequences are rapid increases in levels of aspiration and resulting dissatisfaction with attainment in life (48), marginality, alienation and social deviance (19, 100, 101), lower self-esteem (190), and frustration (53).

PERSONALITY DISPOSITIONS

Environment via Social Structures Influences the Other's Behavior and hence the Person's Personality Dispositions (E → SS → O → P → O → PD)

Minturn & Lambert (125) suggest that E variables (physical structure of living space) and SS variables (number of children in the family, mother's total role requirements) are important antecedents of the mother's (O's) behavior toward the child (P). Munroe & Munroe (126) found larger households among the Logoli of Kenya associated with more frequent care of infants in general (but less by the infant's own mother) than smaller households. Another form of these relations is outlined by Dawson (46, 47). E variables (malnutrition) produce physiological effects (e.g. Kwashiorkor, and endocrinological disorders such as Gynaecomastia). These effects lead to male children of reduced responsiveness and more feminine body form (P). The latter, interacting with socialization practices (SS), elicited maternal behavior (O) different from that given other children, resulting in levels of field dependence (P) more typical of females in that society. This sequence of relations incorporates Bell's (10) suggestion that parents respond differently to genetically determined features of behavior of their children, such as variations in behavioral pacing and impulsiveness of the child; a P→O→P relation.

Social Structure Influences Personality Dispositions

Most cross-cultural studies of socialization and personality fall into this category. The weakest of these studies document a culture difference in behavior, frequently with little theory or empirical data to aid in interpreting the richly confounded differences. Others focus on the mediation of SS→O→P→SS relations. Caudill & Weinstein (33), studying child and caretaker behavior in Japan and the USA, expected that Japanese mothers would (*a*) spend more time with their infants, (*b*) emphasize physical over verbal interaction, and (*c*) have as a goal a contented baby. American mothers would (*a*) spend less time with the infant, (*b*) emphasize verbal over physical interaction, and (*c*) value a self-assertive baby. Trained observers from the local culture made 800 highly reliable observations per child. The major differences were cultural, with the Japanese higher than the American mothers on the observed frequency of presence of the caretaker, amount of positioning of the child, lulling and rocking. The Americans were higher than the Japanese in frequency of chatting, general activity, and playing. Other differences could be traced to the sex of the child and the occupation of the father. Finally, no differences were obtained on variables such as the frequency of feeding, on which there is no reason to expect cultural differences.

Bronfenbrenner (24–26) investigated effects of a social structural variable (number of major socializing agents for P) together with intentions to reveal P's resolutions of a series of moral dilemmas to various O's (parents, peers) on the degree to which P's choices conform to adult norms. He assumed that a child is more able to resist social pressure if he has been exposed to more than one major socializing agent. He will not be forced to give up a single source of security by making contra-adult decisions. Data were obtained in residential and day schools in the USA and USSR. Residential school students (a single socialization setting) gave more adult approved resolutions than day school students. When told that their responses would be seen by their peers, subjects produced more adult resolutions in the USSR. By contrast, in the USA this instruction produced very few adult resolutions, and high rates of such resolutions were obtained only when subjects were told that their responses would be seen by adults.

Other's Behavior as an Antecedent of a Person's Disposition and Behavior

Some studies differentiate the SS→P relation: SS→(P/disposition)→P behavior (143). Others have differentiated SS→(O/behavior)→(P/disposition) →(P/behavior). Amir, Sharan & Kovarsky (4) developed hypotheses concerning rates of volunteering for officer training in the Israeli Defense Forces on the basis of an examination of the family structures of subgroups in Israel. On the basis of Schachter's hypothesis that firstborn sons, particularly in nuclear families, develop a need for affiliation as an anxiety reduction mechanism, and an analysis of the status accorded the firstborn in Middle Eastern extended families, they predicted that (*a*) firstborn sons would show less anxiety avoidance, and therefore more volunteering for officer training, than would later born sons; that (*b*) this difference would not occur in Middle Eastern nuclear families; and that (*c*) in Western families firstborns would show more anxiety avoidance and thus volunteer less frequently. The first two hypotheses were supported, the last only partially. The authors conclude that family structure and role of the firstborn are important variables to be considered in extending the Schachter theoretical formulation to non-Western cultures.

Social Structural Antecedents of Psychopathology and Deviant Behavior

Draguns (57), in his provocative summary of cross-cultural investigations of psychopathology, has noted that only with the recent emergence of the discipline of social psychiatry have systematic observations been applied to the influence of social and cultural factors upon psychopathological manifestations. The issues of central concern in this area can be summarized in two questions: 1. Are diagnostic categories comparable across cultures? 2. Do psychopathological findings from the Western nations have pancultural generality?

Some of the most methodologically sound research concerning the question of cross-national diagnosis has been carried out by the Project on Diagnosis of Mental Disorders in the U. S. and the United Kingdom (special supplement of the *American Journal of Psychiatry* 3). The central problem investigated by the project concerned the frequent finding that first admission rates to mental hospitals and rates for affective disorders were higher in England and Wales than in the United States, while the reverse was true for schizophrenia and cerebral arteriosclerosis. Investigators questioned whether the sources of these observed differences were based on actual clinical differences in samples or differences in diagnostic categorization on the part of clinicians and psychiatrists. Cooper et al (41) attempted to achieve comparability of diagnostic categorization and found that although some of the observed differences could be accounted for by categorization there were in fact genuine clinical differences between the patient populations as well.

Seifert, Draguns & Caudill (149) replicated in Japan the procedures of a recent American diagnostic study and were thereby able to compare the bases of psychiatric diagnosis in the two countries. They found that the same variables serve as "building blocks" of the diagnostic categories in the two countries. However, specific relationships between symptom style and diagnosis were often different or opposite in the two cultures.

Turning to the second question mentioned above, considerable effort has recently been devoted to the study of intercultural generality of psychopathological findings originally established within the United States. Lorr & Klett (116) studied 12 psychiatric syndromes, previously established in the U. S., among newly hospitalized patients in six other countries. Patients were rated by a semistructured interview technique and the pooled ratings were correlated and factored. With few exceptions the existence of the syndromes were confirmed in each sample. Draguns et al (58) extended an American finding concerning the relations between social competence (which consists of factors such as age, marital status, educational achievement, and occupational level) and variables of role orientation (turning against self, turning against others, and avoiding others). At higher levels of competence both Japanese and American men have a tendency to turn against the self.

Murphy, Wittkower & Chance (127) mailed questionnaires to psychiatrists in 30 countries, asking them to rate patients in regard to one type of depression syndrome. They were primarily concerned with the universality of the relationships between depression and level of cohesion in the community. Kitano (107), questioning the impact of acculturation on mental illness, also focused on one diagnostic category, schizophrenia. He questioned Japanese patients in Los Angeles, Hawaii, Tokyo, and Okinawa concerning treatment and behavior of the severely mentally ill. He found a culture-common reaction to schizophrenia, thus suggesting that behavior labeled as mental illness is not acculturable. In general, these studies suggest that there are important similarities across cultures in causes and symptoms of psychiatric disorders.

Suicide and psychogenic death.—In societies in which the individuals' social ties are likely to be weakened, thwarted, or broken by divorce, homicide, etc., and the cause of this behavior is an identifiable individual, there exists what Naroll has called the thwarting-disorientation syndrome. He theorized that the thwarting-disorientation syndrome would lead to a high rate of suicide. Krauss & Krauss (110) examined suicide case histories from 58 cultures and found support for this theory. There was also indirect evidence that early stages of modernization (migration) were related to suicide.

Barrett & Franke (7) have also found cross-national support for a relationship between SS variables and psychogenic death. They hypothesized that social, economic, and medical variables would account for differences in psychogenic death rates, whereas psychological variables would not. In support of this hypothesis, they found that across 30 countries status integration of the labor force by sex correlated positively with homicide and negatively with death from ulcers and suicide. Economic growth correlated with death from ulcers, and wealth correlated positively with suicide. In addition, there was not a significant pattern of cross-lagged correlations between McClelland's psychological motives of achievement, affiliation, and power, operationalized by content analysis of children's stories, and psychogenic death rates.

Drinking.—Beginning with the pioneering research of Horton (89), social scientists have attempted to find out why people drink. Primarily these investigators have correlated amount of alcohol consumed in a culture with characteristics of that culture. Thus, Horton (89), Field (65), Barry et at (8), and McClelland et al (119) have all found correlations between an E variable, type of economy (e.g. hunting, fishing vs agricultural), and a P variable, drinking. In general, hunting tribes drink more heavily than tribes that depend on agriculture for a living. Those researchers have hypothesized and operationalized a number of SS and P intervening variables that might mediate the E→P relation: (*a*) subsistence insecurity (89); (*b*) dependency needs (5); and (*c*) degree of societal organization (65, 100, 119). At present, the degree of societal organization has received the strongest support as the intervening variable mediating type of economy and insobriety. Specifically, in more highly organized societies (e.g. agricultural societies) there are more societal controls that inhibit drinking.

CONCLUDING COMMENT

This review of the cross-cultural psychological literature suggests a number of gaps in research activities. First, we have not made enough progress in our description of the independent variables—ecology, environments, etc—which determine the phenomena of interest. For example, one finds repeatedly the statement that the respondent's level of education is a major determinant of his responses to perceptual, cognitive, or attitudinal tasks. Yet in most studies there is no further analysis of the meaning of the educational variable. What exactly mediates between education and the other phenomena? Is it literacy, participation in institutional environments, the manipulation of symbols, conformity to a life style requiring attention to time, getting rewarded for what you do rather than for who you are, being able to communicate to people you do not see and receive communications from the outside world, or some other variable that mediates between education and cognitive development? Second, there are not enough studies which take the emic-etic dilemma seriously and attempt to design data collection so as to obtain some of the advantages of each approach. There tends to be too much ethnocentrism in the design and execution of psychological studies in other cultures. Third, there is as yet no theoretical framework within which to do such studies. Some fragments do exist, but typically they are not interrelated. New methodologies such as path analysis may make it possible to tie these fragments into more substantial theories.

Our review suggests that the most plausible hypothesis is that basic psychological processes, such as selectivity in perception, are invariant across cultures, but the specific manifestations of the processes, such as what type of stimuli are selected, differ across cultures.

LITERATURE CITED

1. Abate, M., Berrien, F. K. 1967. Validation of stereotypes: Japanese versus American students. *J. Pers. Soc. Psychol.* 7:435–38
2. Al-Issa, I., Dennis, W., 1970. *Cross-Cultural Studies of Behavior.* New York:Holt. 556 pp.
3. *American Journal Psychiatry Suppl.* 1969. Vol. 125 (whole issue)
4. Amir, Y., Sharan, S., Kovarsky, Y. 1968. Birth order, family structure and avoidance behavior. *J. Pers. Soc. Psychol.* 10:271–78
5. Bacon, M., Barry, H., Child, I. 1965. A cross-cultural study of drinking: II. Relations to other features of culture. *Quart. J. Stud. Alc.* 3:29–48
6. Back, K. W., Paramesh, C. R. 1969. Self-image, information exchange and social character. *Int. J. Psychol.* 4:109–18
7. Barrett, G., Franke, R. 1970. "Psychogenic" death: A reappraisal. *Science* 167:304–6
8. Barry, H., Buchwald, C., Child, I., Bacon, M. 1965. A cross-cultural study of drinking: IV. Comparisons with Horton ratings. *Quart. J. Stud. Alc.* 3:62–77
9. Baxter, J. C. 1970. Interpersonal spacing in natural settings. *Sociometry* 33:444–56
10. Bell, R. Q. 1968. A reinterpretation of the direction of effects in studies of socialization. *Psychol. Rev.* 75: 81–95
11. Berlin, B., Kay, P. 1969. *Basic Color Terms: Their Universality and Evolution.* Berkeley/Los Angeles: Univ. California Press. 185 pp.
12. Berrien, F. K. 1965. Japanese vs. American values. *J. Soc. Psychol.* 65:181–92
13. Berrien, F. K. 1966. Japanese and American values. *Int. J. Psychol.* 1:129–42
14. Berrien, F. K. 1968. Cross-cultural equivalence of personality measures. *J. Soc. Psychol.* 75:3–10
15. Berrien, F. K., Arkoff, A., Iwahara, S. 1967. Generation difference in values: Americans, Japanese-Americans and Japanese. *J. Soc. Psychol.* 71:169–76
16. Berry, J. W. 1966. Temne and Eskimo perceptual skills. *Int. J. Psychol.* 1:207–29
17. Berry, J. W. 1967. Independence and conformity in subsistence level societies. *J. Pers. Soc. Psychol.* 7:415–18
18. Berry, J. W. 1969. On cross-cultural comparability. *Int. J. Psychol.* 4: 119–28
19. Berry, J. W. 1970. Marginality, stress and ethnic identification in an acculturated aboriginal community. *J. Cross-Cult. Psychol.* 1:239–52
20. Berry, J. W. 1971. Müller-Lyer susceptibility culture, ecology or race. *Int. J. Psychol.* 6:193–97
21. Berry, J. W., Dasen, P. 1973. *Culture and Cognition: Readings in Cross-Cultural Psychology.* London-Methuen. In press
22. Brewer, M. B. 1968. Determinants of social distance among East African tribal groups. *J. Pers. Soc. Psychol.* 10:279–89
23. Brislin, R. W. 1970. Back-translation for cross-cultural research. *J. Cross-Cult. Psychol.* 1:185–216
24. Bronfenbrenner, U. 1967. Response to pressure from peers versus adults among Soviet and American school children. *Int. J. Psychol.* 2:199–207
25. Bronfenbrenner, U. 1970. Reaction to social pressure from adults versus peers among Soviet day school and boarding school pupils in the perspective of an American sample. *J. Pers. Soc. Psychol.* 15:179–89
26. Bronfenbrenner, U. 1970. *Two Worlds of Childhood: U. S. and U. S. S. R.* New York:Russell Sage Found. 190 pp.
27. Brunswick, E., 1956. *Perception and the Representative Design of Psychological Experiments.* Berkeley: Univ. California Press. 154 pp.
28. Campbell, D. T. 1963. Social attitudes and other behavioral dispositions. In *Psychology: A Study of a Science*, ed. S. Koch, 94–172. New York:McGraw-Hill. 791 pp.
29. Campbell, D. T. 1964. Distinguishing differences of perception from failures of communication in cross-cultural studies. In *Cross-Cultural Understanding: Epistemology in Anthropology*, ed. F. S. C. Northrop, H. H. Livingston. New York: Harper. 396 pp.
30. Campbell, D. T. 1967. Stereotypes

and the perception of group differences. *Am. Psychol.* 22:817–29

31. Campbell, D. T. 1970. Natural selection as an epistemological model. In *A Handbook of Method in Cultural Anthropology*. See Ref. 129, 51–85
32. Campbell, D. T., LeVine, R. A. Ethnocentrism and intergroup relations. In *Theories of Cognitive Consistency: A Sourcebook*, ed. R. P. Abelson et al, 551–64. Chicago:Rand McNally. 901 pp.
33. Caudill, W., Weinstein, H. 1969. Maternal and infant behavior in Japan and America. *Psychiatry* 32:12–43
34. Chaney, R. P., Revilla, R. R. 1969. Sampling methods and interpretation of correlations: A comparative analysis of 7 cross-cultural samples. *Am. Anthropol.* 71:597–633
35. Chemers, M. 1969. Cross-cultural training as a means for improving situational favorableness. *Hum. Relat.* 22:531–46
36. Child, I. L. 1968. Personality in culture. In *Handbook of Personality Theory and Research*, ed. E. F. Borgatta, W. W. Lambert, 82–145. Chicago:Rand McNally. 1232 pp.
37. Child, I. L., Iwao, S. 1968. Personality and esthetic sensitivity: Extension of findings to younger age and to different culture. *J. Pers. Soc. Psychol.* 8:308–12
38. Ciborowski, T., Cole, M. 1971. Cultural differences in learning conceptual rules. *Int. J. Psychol.* 6:25–37
39. Cole, M., Bruner, J. S. 1971. Cultural differences and inferences about psychological processes. *Am. Psychol.* 26:867–76
40. Cole, M., Gay, J., Glick, J. A., Sharp, D. W. 1971. *The Cultural Context of Learning and Thinking: An Exploration in Experimental Anthropology*. New York:Basic Books. 304 pp.
41. Cooper, J., Kendall, R., Gurland, B., Jorkas, T. 1969. Cross-national study of the diagnosis of the mental disorders: Some results from the first comparative investigation. *Am. J. Psychiat. Suppl.* 125:91–114
42. Davis, C. M. 1970. Education and susceptibility to the Müller-Lyer illusion among the Banyankole. *J. Soc. Psychol.* 82:25–34
43. Davis, C. M., Carlson, J. A. 1970. A cross-cultural study of the strength of the Müller-Lyer illusion as a function of attentional factors. *J. Pers. Soc. Psychol.* 16:403–10
44. Davis, E. E., Triandis, H. C. 1971. An experimental study of black-white negotiations. *J. Appl. Soc. Psychol.* 1:240–62
45. Dawson, J. L. M. 1963. Traditional values and work efficiency in a West African mine labor force. *Occup. Psychol.* 37:209–18
46. Dawson, J. L. M. 1967. Cultural and physiological influences upon spatial-perceptual processes in West Africa. *Int. J. Psychol.* 2:115–28; 171–85
47. Dawson, J. L. M. 1967. Traditional versus western attitudes in West Africa: The construction, validation and application of a measuring device. *Brit. J. Soc. Clin. Psychol.* 6:81–96
48. Dawson, J. L. M. 1969. Attitudinal consistency and conflict in West Africa. *Int. J. Psychol.* 4:39–53
49. Dawson, J. L. M. 1969. Exchange theory and comparison level changes among Australian aborigines. *Brit. J. Soc. Clin. Psychol.* 8:133–40
50. Dawson, J. L. M. 1971. Theory and research in cross cultural psychology. *Bull. Brit. Psychol. Soc.* 24:291–306
51. DeVos, G. A., Hippler, A. E. 1969. Cultural psychology: Comparative studies of human behaviors. In *Handbook of Social Psychology*, ed. G. Lindzey, E. Aronson, 4:323–417. Reading, Mass.:Addison-Wesley. 694 pp.
52. Diab, L. N. 1970. A study of intragroup and intergroup relations among experimentally produced small groups. *Genet. Psychol. Monogr.* 82:49–82
53. Diaz-Guerrero, R. 1967. *Exploring dimensions in socio-economic development*. Presented at Int. Conf. Cross-Cult. Gen. Affective Meaning Syst., Tehran, Iran
54. Diaz-Guerrero, R. 1967. Socio-cultural premises, attitudes and cross-cultural research. *Int. J. Psychol.* 2:79–87
55. Doob, L. W. 1967. Scales for assaying psychological modernization in Africa. *Public Opin. Quart.* 31:414–21
56. Dorfman, D. D., Keeve, S., Saslow,

C. 1971. Ethnic identification: A signal detection analysis. *J. Pers. Soc. Psychol.* 18:373–79

57. Draguns, J. 1971. *Investigation of psychopathology across cultures: Issues, findings, directions.* Presented at Int. Counc. Psychol. Symp. APA, Washington, D. C.
58. Draguns, J., Phillips, L., Broverman, I., Caudill, W. 1970. Social competence and psychiatric symptomatology in Japan: A cross-cultural extension of earlier American finding. *J. Abnorm. Psychol.* 75: 68–73
59. Ekman, P., Friesen, W. V. 1971. Constants across cultures in the face and emotion. *J. Pers. Soc. Psychol.* 17:124–29
60. Engebretson, D., Fullmer, D. 1970. Cross-cultural differences in territoriality: Interaction distances of native Japanese, Hawaii Japanese and American Caucasians. *J. Cross-Cult. Psychol.* 1:261–69
61. Ervin-Tripp, S. M. 1969. Sociolinguistics. In *Advances in Experimental Social Psychology*, ed. L. Berkowitz, 91–166. New York: Academic. 386 pp.
62. Etzioni, A. 1969. Social-psychological aspects of international relations. See Ref. 51, 5:538–601
63. Evans, J. L., Segall, M. H. 1969. Learning to classify by color and by function: A study of concept-discovery by Ganda children. *J. Soc. Psychol.* 77:35–53
64. Fiedler, F. E., Mitchell, T. R., Triandis, H. C. 1971. The Culture Assimilator: An approach to cross-cultural training. *J. Appl. Psychol.* 55:95–102
65. Field, P. 1962. A new cross-cultural study of drunkenness. In *Society, Culture and Drinking Patterns*, ed. D. Pittman, C. Snyder, 48–74. New York:Wiley. 616 pp.
66. Fishman, J. A. 1969. Bilingual attitudes and behavior. *Lang. Sci.* 5:5–11
67. Foa, U. G. 1964. Cross-cultural similarity and difference in interpersonal behavior. *J. Abnorm. Soc. Psychol.* 68:517–22
68. Foa, U. G. 1965. New developments in facet design and analysis. *Psychol. Rev.* 72:262–74
69. Foa, U. G. 1966. Perception in behavior in reciprocal roles: The Ringex model. *Psychol. Monogr.* 80:No. 15
70. Foa, U. G., Triandis, H. C., Katz, E. W. 1966. Cross-cultural invariance in the differentiation and organization of family roles. *J. Pers. Soc. Psychol.* 4:316–27
71. Ford, C. S. 1967. *Cross-Cultural Approaches: Readings in Comparative Research.* New Haven:HRAF Press. 305 pp.
72. Foster, M. L. 1968. Componential analysis of grammar: The Tarascan verb. *Int. J. Am. Ling.* 34:259–68
73. Frager, R. 1970. Conformity and anti-conformity in Japan. *J. Pers. Soc. Psychol.* 15:203–10
74. Gay, J., Cole, M. 1967. *The New Mathematics and an Old Culture.* New York:Holt. 100 pp.
75. Ghiglione, R., Beauvois, J. 1970. Perception de soi et perception d'autrui chez les adolescents: Enquète en France et en Grèce. *J. Int. Psychol.* 5:123–33
76. Goodenough, W. H. 1956. Componential analysis and the study of meaning. *Language* 32: 195–216
77. Goodnow, J. J. 1969. Problems in research on culture and thought. In *Studies in Cognitive Development: Essays in Honor of Jean Piaget*, ed. D. Elkind, J. H. Flavell, 439–62. New York:Oxford. 503 pp.
78. Gordon, L. V. 1968. Comments on "cross-cultural equivalence of personality measures." *J. Soc. Psychol.* 75:11–20
79. Gordon, L. V., Kikuchi, A. 1966. American personality tests in cross-cultural research: A caution. *J. Soc. Psychol.* 69:179–84
80. Gordon, L. V., Kikuchi, A. 1970. Response sets of Japanese and American students. *J. Soc. Psychol.* 82:143–48
81. Greenfield, P. M., Bruner, J. S. 1966. Culture and cognitive growth. *Int. J. Psychol.* 1:89–107
82. Guthrie, G. M. 1971. Unexpected correlations and the cross-cultural method. *J. Cross-Cult. Psychol.* 2:315–23
83. Guttman, L. 1959. A structural theory of intergroup beliefs and action. *Am. Sociol. Rev.* 24:318–28
84. Hall, E. T. 1966. *The Hidden Dimension.* New York: Doubleday. 201 pp.
85. Harari, H., McDavid, J. W. 1967. Cultural differences in measuring educational achievement: A chal-

lenge to psychology. *Int. J. Psychol.* 2:209–14

86. Hare, P., Peabody, D. 1971. Attitude content and agreement set in autonomy-authoritarianism items for United States, African and Philippine university students. *J. Soc. Psychol.* 83: 23–31
87. Heron, A. 1971. Concrete operations, 'g,' and achievement in Zambian children. *J. Cross-Cult. Psychol.* 2:325–36
88. Herskovits, M. J. 1955. *Cultural Anthropology.* New York: Knopf. 569 pp.
89. Horton, D. 1943. The functions of alcohol in primitive societies: A cross-cultural study. *Quart. J. Stud. Alc.* 4:199–320
90. Hudson, W. 1960. Pictorial depth perceptions in sub-cultural groups in Africa. *J. Soc. Psychol.* 52:183–208
91. Inkeles, A. 1969. Making men modern: On the causes and consequences of individual change in six developing countries. *Am. J. Sociol.* 75:208–25
92. Inkeles, A., Levinson, D. J. 1969. National character: The study of modal personality and sociocultural systems. See Ref. 51, 4:418–506
93. Irvine, S. H. 1969. Factor analyses of African abilities and attainments: Constructs across cultures. *Psychol. Bull.* 71:20–32
94. Irvine, S. H. 1970. Affect and construct: A cross-cultural check on theories of intelligence. *J. Soc. Psychol.* 80:23–30
95. Iwao, S., Child, I. L. 1966. Comparison of esthetic judgments by American experts and Japanese potters. *J. Soc. Psychol.* 68:27–34
96. Iwao, S., Child, I. L., Garcia, M. 1969. Further evidence of agreement between Japanese and American esthetic evaluations. *J. Soc. Psychol.* 78:11–16
97. Jahoda, G. A. 1970. A cross-cultural perspective in psychology. *Advan. Sci.* 27:1–14
98. Jahoda, G. A. 1971. Retinal pigmentation, illusion susceptibility and space perception. *Int. J. Psychol.* 6:199–208
99. Jensen, A. R. 1969. How much can we boost IQ and scholastic achievement? *Harvard Educ. Rev.* 39:1–123
100. Jessor, R., Graves, T. D., Hanson, R. C., Jessor, S. L. 1968. *Society, Personality and Deviant Behavior: A Study of a Tri-Ethnic Community.* New York:Holt. 500 pp.
101. Jessor, R., Young. H. B., Young, E. B., Tesi, G. 1970. Perceived opportunity alienation and drinking behavior among Italian and American youth. *J. Pers. Soc. Psychol.* 15:215–22
102. Kagitcibasi, C. 1970. Social norms and authoritarianism: A Turkish-American comparison. *J. Pers. Soc. Psychol.* 16:444–51
103. Kahl, J. A. 1968. *The Measurement of Modernism: A Study of Values in Brazil and Mexico.* Austin: Univ. Texas Press. 210 pp.
104. Kelley, H. H. et al 1970. A comparative experimental study of negotiation behavior. *J. Pers. Soc. Psychol.* 16:411–38
105. Kelman, H. C., Hollander, E. P. 1964. International cooperation in psychological research. *Am. Psychol.* 19:779–82
106. Kikuchi, A., Gordon, L. V. 1970. Japanese and American personal values: Some cross-cultural findings. *Int. J. Psychol.* 5:183–87
107. Kitano, H. 1970. Mental illness in four cultures. *J. Soc. Psychol.* 80: 121–34
108. Koffka, K. 1935. *Principles of Gestalt Psychology.* New York:Harcourt, Brace. 720 pp.
109. Kohn, M. L. 1969. *Class and Conformity: A Study of Values.* Homewood: Dorsey. 315 pp.
110. Krauss, H. H., Krauss, B. J. 1968. Cross-cultural study of the thwarting-disorientation theory of suicide. *J. Abnorm. Psychol.* 73:353–57
111. Labov, W. 1970. The logic of nonstandard English. In *Language and Poverty*, ed. F. Williams, 153–89. Chicago:Markham. 459 pp.
112. Lambert, W. E., Klineberg, O. 1967. *Children's Views of Foreign Peoples.* New York:Appleton. 319 pp.
113. Lambert, W. W., Weisbrod, R. 1971. *Comparative Perspectives on Social Psychology.* Boston: Little, Brown. 309 pp.
114. Lazarus, R. S., Tomita, M., Opton, J., Kodama, M. 1966. A cross-cultural study of stress-reaction patterns in Japan. *J. Pers. Soc. Psychol.* 4:622–33
115. Little, K. B. 1968. Cultural variations

in social schemata. *J. Pers. Soc. Psychol.* 10:1–7

116. Lorr, M., Klett, C. J. 1969. Cross-cultural comparison of psychotic syndromes. *J. Abnorm. Psychol.* 74:531–43

117. Luria, A. K. 1971. Towards the problems of the historical nature of psychological processes. *Int. J. Psychol.* 6:259–72

118. McClelland, D. 1961. *The Achieving Society.* Princeton, N.J.:Van Nostrand. 512 pp.

119. McClelland, D. C., Davis, W., Wanner, E., Kalin, R. 1966. A cross-cultural study of folk-tale content and drinking. *Sociometry* 29:308–33

120. McClelland, D. C., Winter, D. G. 1969. *Motivating Economic Achievement.* New York:Free Press. 409 pp.

121. Malpass, R. S., Kravitz, J. 1969. Recognition for faces of own and other race. *J. Pers. Soc. Psychol.* 13:330–34

122. Manaster, G., Havighurst, R. J. 1971. *Cross-National Research: Social Psychological Methods and Problems.* New York:Houghton-Mifflin. 224 pp.

123. Meade, R. 1970. Leadership studies of Chinese and Chinese-Americans. *J. Cross-Cult. Psychol.* 1: 325–32

124. Miller, W. R. 1969. Language. In *Biennial Review of Anthropology,* ed. B. J. Siegel, 1–40. 404 pp.

125. Minturn, L., Lambert, W. W. 1964. *Mothers of Six Cultures.* New York: Wiley. 351 pp.

126. Munroe, R. H., Munroe, R. L. 1971. Household density and infant care in an East African society. *J. Soc. Psychol.* 83:3–13

127. Murphy, H., Wittkower, E., Chance, N. 1967. Cross-cultural inquiry into the symptomatology of depression: A preliminary report. *Int. J. Psychiat.* 3:1–58

128. Naroll, R. 1970. What have we learned from cross-cultural surveys? *Am. Anthropol.* 72:1227–87

129. Naroll, R., Cohen, R., Eds. 1970. *A Handbook of Method in Cultural Anthropology.* Garden City, NY: Natur. Hist. Press. 1017 pp.

130. Osgood, C. E. 1964. Semantic differential technique in the comparative study of cultures. *Am. Anthropol.* 66:171–200

131. Osgood, C. E. 1965. Cross-cultural comparability in attitude measurement via multilingual semantic differentials. In *Current Studies in Social Psychology,* ed. I. D. Steiner, M. Fishbein, 95–107. Chicago: Holt. 532 pp.

132. Osgood, C. E. 1967. On the strategy of cross-cultural research into subjective culture. *Soc. Sci. Inform.* 6:1–37

133. Osgood, C. E. 1970. Speculations on the structure of interpersonal intentions. *Behav. Sci.* 15:237–54

134. Osgood, C. E. 1971. Explorations in semantic space: A personal diary. *J. Soc. Issues* 27:5–59

135. Pareek, U. 1968. A motivational paradigm of development. *J. Soc. Issues* 26:115–24

136. Pepitone, A. et al 1970. Justice in choice behavior: A cross-cultural analysis. *Int. J. Psychol.* 5:1–10

137. Peterson, D. R., Migliorino, G. 1967. Pancultural factors of parental behavior in Sicily and the U. S. *Child Develop.* 38:967–92

138. Piaget, J. 1966. Necessité et signification des recherches comparatives en psychologie genètique. *Int. J. Psychol.* 1:3-13

139. Pike, K. L. 1966. *Language in Relation to a Unified Theory of the Structure of Human Behavior.* The Hague:Mouton. 762 pp.

140. Price-Williams, D. R. 1969. *Cross-Cultural Studies: Selected Readings.* Middlesex, England:Penguin. 383 pp.

141. Przeworski, A., Teune, H. 1967. Equivalence in cross-cultural research. *Public Opin. Quart.* 30: 551–68

142. Przeworski, A., Teune, H. 1969. *Logic of Comparative Social Inquiry.* New York:Wiley. 153 pp.

143. Rabin, A. I., Goldman, H. 1966. The relationship of severity of guilt to intensity of identification in Kibbutz and non-Kibbutz children. *J. Soc. Psychol.* 69:159–64

144. Rahe, R. H. 1969. Multi-cultural correlations of life change scaling: America, Japan, Denmark and Sweden. *J. Psychosom. Res.* 13: 191–95

145. Rohner, R., Katz, L. 1970. Testing for validity and reliability in cross-cultural research. *Am. Anthropol.* 72:1068–73

146. Schnaiberg, A. 1970. Measuring modernism: Theoretical and empirical explorations. *Am. J. Sociol.* 76:399–425

147. Schuman, H. 1966. Social change and the validity of regional stereotypes in East Pakistan. *Sociometry* 29:426–40
148. Segall, M. H., Campbell, D. T., Herskovits, M. J. 1966. *The Influence of Culture on Visual Perception.* Indianapolis:Bobbs-Merrill. 268 pp.
149. Seifert, J., Draguns, J., Caudill, W. 1971. Role orientation, sphere dominance, and social competence as bases of psychiatric diagnosis in Japan: A replication and extension of American findings. *J. Abnorm. Psychol.* 78:101–6
150. Shaffer, M., Sundberg, N., Tyler, L. E. 1969. Content differences on word listing by American, Dutch, and Indian adolescents. *J. Soc. Psychol.* 79:139–40
151. Sherwood, J. J., Nataupsky, M. 1968. Predicting the conclusions of Negro-White intelligence research from biographical characteristics of the investigator. *J. Pers. Soc. Psychol.* 8:53–58
152. Singh, N. 1969. n/Ach among successful-unsuccessful and traditional-progressive agricultural entrepreneurs of Delhi. *J. Soc. Psychol.* 79:271–72
153. Singh, N. 1970. n/Ach among agricultural and business entrepreneurs of Delhi. *J. Soc. Psychol.* 81:145–50
154. Smith, F. J., Crano, W. D. 1971. Concerning the possibility of cross-cultural research. *Proc. Ann. Conv. APA* 6:217–18
155. Sommer, R. 1968. Intimacy ratings in five countries. *Int. J. Psychol.* 3:109–14
156. Stephenson, J. 1968. Is everyone going modern? A critique and a suggestion for measuring modernism. *Am. J. Sociol.* 74:265–75
157. Szalay, L. B., Moon, W. T., Bryson, J., Paternak, W. P. 1971. *Communication Lexicon on Three South Korean Audiences: Social, National and Motivational Domains,* 1–245. Kensington, Md.: Am. Inst. Res.
158. Szalay, L. B., Windle, C., Lysne, D. A. 1970. Attitude measurement by free verbal associations. *J. Soc. Psychol.* 82:43–55
159. Tajfel, H. 1969. Cognitive aspects of prejudice. *J. Soc. Issues* 25:79–97
160. Tajfel, H. 1969. Social and cultural factors in perception. See Ref. 51, 3:315–94
161. Tajfel, H., Nemeth, C., Jahoda, G., Campbell, J. D., Johnson, N. 1970. The development of children's preference for their country: A cross-national study. *Int. J. Psychol.* 4:245–53
162. Tapp, J. L., Kohlberg, L. 1971. Developing senses of law and legal justice. *J. Soc. Issues* 27:65–91
163. Triandis, H. C. 1964. Cultural influences upon cognitive processes. In *Advances in Experimental Social Psychology*, ed. L. Berkowitz, 1–48. New York:Academic. 319 pp.
164. Triandis, H. C. 1964. Exploratory factor analyses of the behavioral component of social attitudes. *J. Abnorm. Soc. Psychol.* 68:420–30
165. Triandis, H. C. 1967. Toward an analysis of the components of interpersonal attitudes. In *Attitudes, Ego-Involvement and Change,* ed. C. Sherif, M. Sherif, 227–70. New York:Wiley. 264 pp.
166. Triandis, H. C. 1968. Some cross-cultural studies of cognitive consistency. See Ref. 32, 723–30
167. Triandis, H. C. 1971. *Attitude and Attitude Change.* New York:Wiley. 232 pp.
168. Triandis, H. C., Kilty, K., Shanmugam, A. V., Tanaka, Y., Vassiliou, V. 1972. Cognitive structures and the analysis of values. See Ref. 174, 181–262
169. Ibid. A cross-cultural study of role perceptions, 263–98
170. Triandis, H. C., Malpass, R. S., Davidson, A. R. 1972. Cross-cultural psychology. In *Biennial Review of Anthropology: 1971,* 1–84
171. Triandis, H. C., Vassiliou, V. 1967. Frequency of contact and stereotyping. *J. Pers. Soc. Psychol.* 7:316–28
172. Triandis, H. C., Vassiliou, V. 1972. Interpersonal influence and employee selection in two cultures. *J. Appl. Psychol.* 56:140–45
173. Triandis, H. C., Vassiliou, V., Nassiakou, M. 1968. Three cross-cultural studies of subjective culture. *J. Pers. Soc. Psychol.* 8:1–42
174. Triandis, H. C., Vassiliou, V., Vassiliou, G., Tanaka, Y., Shanmugam, A. V., Eds. 1972. *The Analysis of Subjective Culture.* New York:Wiley. 383 pp.
175. Triandis, H. C., Vassiliou, V., Thomanek, E. K. 1966. Social

status as a determinant of respect and friendship acceptance. *Sociometry* 29:396–405
176. Tsushima, W. T. 1968. Responses of Irish and Italian patients of two social classes under preoperative stress. *J. Pers. Soc. Psychol.* 8:43–48
177. Vassiliou, V., Triandis, H. C., Vassiliou, G., McGuire, H. 1972. Interpersonal contact and stereotyping. See Ref. 174, 89–115
178. Warr, P. B., Schroder, H. M., Blackman, S. 1969. The structure of political judgment. *Brit. J. Soc. Clin. Psychol.* 8:32–43
179. Werner, O., Campbell, D. T. 1970. Translating, working through interpreters and the problem of decentering. See Ref. 129, 398–420
180. Whiting, J. W. M. 1964. Effects of climate on certain cultural practices. In *Explorations in Cultural Anthropology*, ed. W. H. Goodenough, 496–544. New York:McGraw-Hill. 635 pp.
181. Whiting, J. W. M. 1968. Methods and problems in cross-cultural research. See Ref. 51, 2:693–728
182. Whiting, J. W. M., Child, I. L. 1953. *Child Training and Personality*. New Haven:Yale Univ. Press. 353 pp.
183. Whitney, R. E. 1971. Agreement and positivity in pleasantness ratings of balanced and unbalanced social situations. *J. Pers. Soc. Psychol.* 17:11–14
184. Whittaker, J. O., Meade, R. D. 1967. Sex of the communicator as a variable in source credibility. *J. Soc. Psychol.* 72:27–34
185. Whittaker, J. O., Meade, R. D. 1968. Retention of opinion change as a function of differential source credibility: A cross-cultural study. *Int. J. Psychol.* 3:103–8
186. Witkin, H. A. 1967. A cognitive style approach to cross-cultural research. *Int. J. Psychol.* 2:233–50
187. Wober, M. 1969. Distinguishing centricultural from cross-cultural tests and research. *Percept. Mot. Skills* 28:488
188. Wober, M. 1971. Adapting Dawson's traditional versus western attitudes scale and presenting some new information from Africa. *Brit. J. Soc. Clin. Psychol.* 10:101–13
189. Zax, M., Takahashi, S. 1967. Cultural influences on response style: Comparisons of Japanese and American college students. *J. Soc. Psychol.* 71:3–10
190. Ziller, R. C., Long, B. H., Ramana, K. V., Reddy, W. E. 1968. Self-orientations of Indian and American adolescents. *J. Pers.* 36:316–30

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PERSONNEL ATTITUDES AND MOTIVATION[1] 206

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Past reviewers of job satisfaction and work motivation research such as Hinrichs (38), Lawler (49), Locke (54), and Viteles (109) have often argued that insufficient systematic conceptualization in this area has tended to yield a stream of unrelated fragments, but little real understanding. After reviewing publications appearing in the 1969–71 period, we feel that recent research efforts warrant a review which focuses primarily on theoretical issues, reflecting the beginning of the type of systematic theory-research interplay that characterizes any mature field of scientific inquiry. Our decision to proceed in terms of theory-oriented research was guided not only by our conviction that theoretical issues need the major attention of satisfaction and motivation researchers, but also by our knowledge that recent reviews covering the basically nontheoretical research are available (79, 80).

Much of the current research is characterized by attempts to test isolated hypotheses selected on some intuitive and not explicitly stated bases. To the extent that theoretical and substantive issues are de-emphasized, research results tend to be noncumulative and fail to produce a systematically integrated body of knowledge.

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[1] This review covers material published since the last review dealing with the topic written by Hinrichs (38). In an extensive (but less than exhaustive) search of the literature, more than 1000 articles, books, monographs, and technical reports related to job attitudes and work motivation were uncovered.

Two considerations led us to reduce the number of citations in this review: (*a*) the limited allotment of space to cover the rather complex and often controversial topic areas; and (*b*) more importantly, our decision to follow the Editorial Committee's recommendation to discuss critically the current state of research and theory in the field rather than to present an encyclopedic coverage of publications. We have concentrated on theoretical issues at the expense of publications that do not address themselves to some explicitly stated theoretical issue or that are not directly relevant to such issues. When a number of articles are relevant to a given point or line of inquiry, we cite only one or two which exemplify the point to be made.

Although we have found many interesting and informative unpublished manuscripts or preprints, we decided, with only a few exceptions, not to review such materials because of space limitations.

[2] The writers are indebted to Sharon Dorfman and Monica Schaeffer for their invaluable help in the mechanics of the literature review and with the preparation of the manuscript. We also are most appreciative of the efforts of our colleagues Edwin A. Locke and Benjamin Schneider in reading earlier drafts of this paper and commenting on them.

A large proportion of studies in satisfaction and work motivation have attempted to deal, directly or indirectly, with hypothetical unobservable constructs (e.g. need, frame of reference, feelings of inequity, intention, goal, value, force) on the basis of private reports elicited with the help of paper and pencil instruments or interview techniques. If one takes the position that internal organismic processes are the immediate antecedents of behavior in organizations, the prevailing atheoretical, behavioristic logic makes support of statements referring to these processes impossible (18, 70).

Furthermore, if one wishes to make causal statements about organizational behaviors rather than merely to describe a sequence of events, the procedure of looking for "functional relationships," focusing solely on the empirical relationship among external variables and verbal reports or other behaviors, provides but a starting point for scientific research and makes causal explanations tenuous at best (54).

In order to better deal with both the problem of hypothetical, unobservable constructs as well as the problem of causal explanations of organizational behavior, explicit and articulated conceptualization of the constructs of interest, their properties and interrelationships is a prerequisite to research and measurement. A valuable overview of such construct validation and the logic of theoretical networks related to instrumentality theories of motivation has been presented by Mitchell & Biglan (70). Locke (54), in discussing the problem of causal explanation in job satisfaction research strongly emphasizes the need for theory-related research and measurement and the abandonment of the logic of "correlation without explanation."

Although there is still an overabundance of nonsystematic, atheoretical research, motivation and job attitude research in organizational psychology has progressed slowly from common sense viewpoints regarding attitudes and motivation to a more systematic investigation of human motivation in organizations, in parallel with motivation research in other areas of psychology. This progress has produced a whole set of new problems which will be summarized throughout this review. Progress from the common sense viewpoint to systematic theory building is reflected in some of the recent theory-oriented review articles and books on satisfaction and work motivation. The comprehensive treatment of managerial performance and effectiveness by Campbell and associates (8) and Lawler's (50) valuable overview of the motivational effects of pay on organizational effectiveness present extensive research reviews organized around certain theoretical models and approaches. Similarly, review articles covering this area, such as those by Cummings & Schwab (11), Hunt & Hill (42), Lawler (49), and Wofford (118), have dealt increasingly with theoretical issues, discussing research which springs from or is related to more or less developed theoretical models and approaches.

PROCESS THEORIES

It seems useful to break down the various theories, models, and grand hypotheses into two overlapping categories, following the lead of Campbell et al (8). The first category includes theories which have focused mainly on the processes of motivation and satisfaction, while the second category includes theoretical positions focusing primarily on content issues of motivation and satisfaction. Space limitations do not allow for separate discussions of satisfaction and motivation within the two theory categories, although such a differentiation would be highly desirable. Despite a few determined adherents to the belief that attitudes in some way directly cause behaviors, it seems clear from the research reviews of Fishbein & Ajzen (25), Lawler (49), and Locke (55) that this hypothesis is unsupported and is an oversimplification of the determinants of behavior. A much sounder approach, advocated by Cummings & Schwab (11), is to develop separate theories of job attitudes and work motivation.

VALENCE-INSTRUMENTALITY-EXPECTANCY (VIE) THEORIES

The cognitive models of motivation and satisfaction have inspired a variety of research questions which begin to provide a general explanatory framework for behavior in organizations. Organizational behavior is viewed as a function of the interaction of personality (e.g. ability, values, needs, expectancies, instrumentalities, and role demands) and the general environment (e.g. organizational contingencies, environmental constraints, supervision, available alternatives). Thus VIE theories are congruent with those approaches which attempt to integrate the structuralistic and personalistic views of organizations. Lichtman & Hunt (52), in reviewing the main trends in organizational theorizing, conclude that the integrating approaches provide a better understanding of behavior in organizations than do the one-sided normative theories of organizations.

Evidence.—The VIE theories hold that motivation is a function of the interactions between effort-performance expectations, performance-outcome instrumentalities, and valences of outcomes. The results of investigations concerning the interactive effects of the VIE theory components on effort expenditure by Mitchell & Albright (69), Mitchell & Nebeker (71), and Schuster, Clark & Rogers (95), and investigations on rated or actual performance by Dachler & Mobley (14), Graen (32), Mitchell & Albright (69), Mitchell & Nebeker (71), and Schuster, Clark & Rogers (95), as well as studies looking at VIE predictions concerning attitudes towards various aspects of jobs or careers in general by Deci & Vroom (16), Sheard (99), and Wanous (111), provide moderate support for VIE models. However, a closer examination of the research reveals a disturbing number of inconsistent findings. Researchers have compared the VIE components (valence, instrumentality, expectancy) with the total motivation index in predicting effort, performance, or satisfaction measures. Graen (32) finds instrumentality measures and Dachler & Mobley (14) and Mitchell & Nebecker (71) find expectancy measures to be the most important components of the VIE model from a predictive viewpoint. In many cases the calculated index of satisfaction or motivation did not predict satisfaction ratings or behavior any better than some of the components making up the motivation indices (32, 69, 71, 99). Mitchell & Albright (69), for example, found strong support for the satisfaction model but not for the effort and performance model. Yet another investigation by Mitchell & Nebeker (71) provided support for the job effort model but not for the satisfaction model. In short, although a number of authors have concluded that VIE theories show promise of providing a scientifically useful model of work motivation and satisfaction (32, 49, 70, 73), the available evidence, although consistent in some respects, is remarkably weak and contradictory in other respects.

This conclusion is in part attributable to the fact that the design of the studies and the measures used to assess component variables often have not conformed fully to the strict requirements of VIE theory (22, 39, 118). There exists a great deal of confusion concerning the definition of valence. Researchers have not distinguished between anticipated satisfaction (valence) and experienced satisfaction (value). In addition, almost without exception valence has been assessed with measures of importance. Clearly, the concept of importance has to be distinguished from the concept of evaluation (13, 25, 75). In a similar vein, the concept of instrumentality has been inconsistently handled. Some, such as Campbell and co-workers (8), argue that instrumentality is just a second expectancy term. Others, such as Graen (32), hold to the original view that this concept is something akin to a "cognitive correlation." Dachler & Mobley (14) have combined the two arguments by decomposing the instrumentality summary rating into a series of perceived conditional probabilities. Heneman & Schwab (37) and Mitchell (68) have summarized other problems, discrepancies, and theoretical shortcomings in the VIE theory literature. Clearly, if VIE models are to maintain the usefulness which so many researchers have attributed to them, more effort needs to be expended in careful theoretical analyses and theory-based empirical research.

Extensions and modifications.—Increasingly, researchers have tried to change the original ahistorical emphasis of VIE models by investigating the environmental and experiential determinants of the model's components. It may be one of VIE theory's most promising attributes that it provides a framework within which the processes of personality and organization integration can be investigated and understood.

There have been a number of studies dealing with the effects of actual performance (effort)-work outcome contingencies on perceived instrumentality (32) and on satisfaction and performance (10, 14, 32, 93, 120). Graen (32) finds that perceived instrumentalities correspond to the actual contingencies set up in the study. Although Graen's design and manipulation may allow for alternative explanations of the data, his results indicate that his model predicts satisfaction and performance only where work outcomes (achievement feedback) are made contingent upon effective performance. Schneider & Olson (93) also find that attitude towards pay is related to performance only where pay is actually contingent upon effective performance. Furthermore, interorganizational differences in the effort-pay contingencies result in interorganizational differences in rated effort expenditure.[3]

Dachler & Mobley (14) looked at VIE theory predictions of work behavior and goal setting across two organizations with different organizational characteristics. Results consistently supported VIE theory predictions in the organization which appeared to provide conditions (e.g. incentive system, structured tasks, intensive training for incoming employees, few hierarchical levels) that allowed for accurate perceptions about the consequences of alternative performance levels. VIE theory predictions were not consistently supported in the organization which appeared to provide conditions which hindered accurate perceptions about consequences of alternative behaviors (e.g. salaries paid according to job rating with no incentive plan, employees frequently moved from one job to another, only customary orientation training for incoming employees, many hierarchical levels). Furthermore, organizational tenure moderated the relationships among the cognitive variables, goal setting, and performance.

Thus, not only do actual performance-outcome contingencies seem to affect perceived instrumentality, performance, and satisfaction, but other organizational characteristics seem to serve as environmental constraints limiting levels of performance, or they serve as conditions which impede the accuracy or realism of employee perception and conclusions. To the extent that these hypothesized thought processes are immediate determinants of behavior, the investigation of the interaction between organizational environment, individual differences, and employee thought processes should contribute considerably to the understanding of organizational behavior.

Some recent studies have investigated the effects of supervisory behavior (consideration and structure) on the VIE motivation process (22, 39). Based upon the assumptions that the supervisor can affect employee satisfactions through facilitating or blocking value attainment, and that he can affect performance by setting contingencies between effective performance and valued outcomes, these investigators argue that consideration behavior on the part of the supervisors should affect the availability of desirable outcomes, whereas structuring behavior of the supervisor should affect contingencies which are established between work outcomes and behaviors. Evans (22) found some support for the hypothesis that leader behavior affects satisfaction through its impact on path-goal instrumentalities. However, assumptions concerning how consideration and structure affect subordinate cognitions remain untested. House (39), using a similar model and adding situational variables which were predicted to moderate the effects of leader behavior, investigated a path-goal theory of leader effectiveness. However, since he did not use measures of the constructs specified by the path-goal model, the theoretical meaning of his results is difficult to establish.

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[3] Cherrington, Reitz & Scott (10), Nord (77), and Yukl, Wexley & Seymore (120) have all raised issues which lead to a comparison of VIE theory and the operant conditioning literature. The latter (120), for example, investigated the effects of different pay reinforcement schedules by comparing VIE theory predictions with operant conditioning principles. Since these studies did not assess the cognitive variables required by VIE theory, it is difficult to evaluate the meaning of these results for VIE theory. Nevertheless, the competitive evaluation of VIE theory with operant conditioning predictions concerning motivation requires further research efforts, especially in view of the fact that VIE theories typically have not included propositions regarding how expectancies and instrumentalities are acquired.

Although the treatment of leadership as part of the process of employee motivation, rather than in terms of trait lists or behavior styles, is an exciting and long-overdue innovation, the utility and theoretical meaningfulness of combining VIE theory and the Ohio State leadership dimensions appears questionable. The two approaches derive from different traditions, and in certain instances are based upon contradictory assumptions. Rather than using the existing consideration and structure dimensions, each of which contain elements that in all probability have differing significance for VIE theory components, it would appear to be more promising to develop leadership measures which take into account the basic theoretical assumptions about the process by which leaders affect their followers. In order to do that, however, a more careful theoretical analysis of the leadership process and its relationship to organizational value structures needs to be undertaken. Locke (56) argues that leaders may affect subordinates' motivation through facilitation or blocking of value attainment.

Even though VIE theory was presented as a general motivation model, it has been tested mainly with regard to performance criteria. Deci & Vroom (16) look at VIE explanations of career choice, Dachler & Mobley (14) deal with turnover and absenteeism, and Mitchell & Albright (69) with turnover. However, the evidence is not clear as to whether VIE models as presently conceived provide equally convincing explanations of all forms of behavior.

A number of investigators have extended the basic VIE model by adding components. Lawler (50) has attempted to integrate personality variables (internal/external control of reinforcement, self-esteem) and hypotheses stemming from equity theory and need hierarchy theory into the basic VIE model. Graen (32) has added internal and external pressures for effort and Mitchell & Nebeker (71) have added expectations of peers.

Understanding regarding the basic VIE model is still rudimentary, and the knowledge of the properties, antecedents, and determinants of the VIE theory components is limited. Therefore, the addition of terms to the basic theory, without careful research and conceptualization, introduces the risk that the utility and power of the VIE theory may be rapidly diminished.

There is a need for much more research, not only testing the basic VIE model, but also testing competing explanations of motivation and of satisfaction. A few authors—among them Bass, Rosen & Hill (4), Wofford (118), and Yukl, Wexley & Seymore (120)—have already taken this comparative approach. An interesting comparison of theories of pre and post performance satisfaction was undertaken by Sobel (104). Results indicated little support for the valence times subjective probability hypothesis. Instead, the findings fit the subtractive model as stated by Steiner (106). These results, if replicated in other less restrictive situations, have important implications for VIE models.

Theorists might benefit from a consideration of the issues and empirical findings that have been presented by certain decision theorists and researchers on information processing such as those of Slovic & Lichtenstein (102). Furthermore, more attention should be given to the effects of job characteristics, as indicated by Hackman's (34) careful delineation of the role of tasks in behavioral research, and by Lifter, Bass & Nussbaum's (53) research dealing with effort expenditures of line and staff personnel. Finally, individual difference variables such as variations in decision strategies (e.g. maximizing versus satisficing) and the different ways of combining and using cognitions considered by Einhorn (20, 21) should be integrated into VIE models and studied.

Theories of Goal Setting and Intentional Behavior

Closely related to the tradition which gave rise to the VIE models are theories dealing with the motivational properties of intentions and related constructs such as task, purpose, desire, and goal. Although attempts have been made to integrate the phenomenon of goal setting into VIE theory by Arvey & Dunnette (2), Campbell et al (8), and Mobley (74), explanatory frameworks of intentional behavior have typically been broader than VIE theories, covering more extensively and systematically the relation of the phenomenal field to intention and performance (25, 89). It is surprising that researchers attempting to study the cognitive processes underlying work motivation have not made more use of the fairly extensive literature related to intentional behavior and to motivational properties of goals.

Ryan's book (89) on intentional behavior clearly represents a significant contribution to the understanding of human motivation. Noting that most recent theories of motivation have not used intentions as an explanatory factor in behavior, he set out to summarize research and theories bearing upon the problem of goals and intentions as immediate instigators of activity, both in the area of work motivation and in other areas of psychology. In the process, Ryan has developed a systematic approach to human motivation which not only encourages integration of the process and content approaches to motivation but also provides a firm basis for the systematic exploration of the cognitive aspects of work motivation.

Another carefully articulated conceptualization of task motivation in terms of goals, intentions, and value judgments is represented by the work of Locke (54, 55, 58–60). Locke argues and presents evidence indicating that satisfaction is a function of value judgments which he defines as the perceived relationship between what is perceived to exist (or anticipated to exist) in a job situation and a person's value standards and goals (54, 55). Ilgen (43) reports that satisfaction with performance is a function of both the level of performance and the interaction between level of performance and the extent to which actual performance deviates from expected performance. Even though Ilgen does not use the concepts of value standards or goals, his findings may prove to be consistent with Locke's conceptualizations.

A major hypothesis of Locke's motivation model is that goals and intentions are the most immediate determiners of performance (55, 60). Some of Locke's studies seem to indicate, for example, that hard or difficult goals lead to higher performance rates than do easy goals (58, 60) and that subjects who are given feedback with regard to different task parameters perform better on the performance dimensions they decide to maximize and worse on those dimensions which they choose to ignore or minimize (59). Locke also contends that external incentives affect performance through their impact on a person's goals and intentions (58, 60). On the basis of these arguments, Locke comes to the conclusion, as have Cummings & Schwab (11) among others, that performance produces satisfaction to the extent that it leads to the attainment of important job values or goals. Satisfaction is seen as an incentive to action but it does not determine choice of goals which are the direct antecedent of behavior (55).

Although Locke's theoretical arguments have made significant inroads in the understanding of intentional behavior, the experimental evidence is not entirely conclusive (89). There are some bothersome design and analysis problems which have been noted by Cummings, Schwab & Rosen (12), as well as the liberal use of difference scores as predictors of satisfaction, subsequent goal choice, and performance, which make it desirable that some of the conclusions drawn from these studies be investigated further. We would agree with Ryan (89) that the studies on goals and intentions which were conducted mainly in the laboratory should be extended to a field setting. Furthermore, Locke's research has focused mainly upon the effects of goals on performance while relatively little is known about the determinants of goal setting. However, studies by Arvey & Dunnette (2) and Mobley (74) have investigated the antecedents of goal setting within a VIE framework, finding that people choose those levels of performance as their goals which they expect to be able to reach and which are most desirable. A study by Cummings, Schwab & Rosen (12) found that level of previous performance plus amount and accuracy of knowledge of results were significantly related to the goal level set by subjects.

Some of the theoretical arguments presented by Locke show striking similarities with other theoretical models such as VIE theory and the theory of achievement motivation articulated by Atkinson & Feather (3). Closer examination, however, reveals a number of important differences in emphases as well as outright disagreements (60). Therefore, research testing competing hypotheses is an important next step in the process of understanding intentional behavior.

The goal theories discussed to this point have focused on individuals as the unit of analysis. The effects of goals, their determinants, and their consequences within groups have been investigated by Zander and his associates (121) in a unique and extensive research program. Zander sought to determine whether theories of intentional behavior for individuals are useful in explaining purposeful group behavior. The outcome of this critical project was a set of integrating assumptions and hypotheses dealing with the characteristics and effectiveness of groups in terms of group goals and individual motives and setting forth some of the determinants of these goals and motives. Many of the assumptions and hypotheses were supported by the results of studies conducted by the investigators.

A parallel development to the literature on the motivational effects of goals is the increasingly popular Management by Objectives (MBO) approach. Although some of the assumptions on which MBO is based have counterparts in the theoretical literature on goal setting and motivation, the bulk of the existing MBO literature is primarily descriptive or prescriptive in nature. A few notable exceptions are provided by researchers such as Carroll & Tosi (9), who have investigated the extent to which the effects of the difficulty and importance of goals on self-report criteria of MBO effectiveness are moderated by managerial personality traits. Other attempts to investigate the motivational processes of MBO programs by Dunbar (19) and Ivancevich, Donnelly & Lyon (45) show that changes occur in the perceived need satisfactions of MBO participants, that goals significantly affect performance, and that monetary incentives may have an effect on goal level if rewards depend strictly on goal achievement.

The MBO approach not only seeks to take advantage of the motivational consequences of goal setting, but also uses such approaches as participation as a means of achieving commitment to goals, giving knowledge of results with regard to achievement or nonachievement of goals, and other motivating principles advanced by human relations theorists. Thus it clearly provides an excellent vehicle for integrating different theoretical approaches and for collecting the kind of empirical data which could increase our understanding of the effects of the phenomenal field on purposive behavior.

EQUITY THEORY

A number of excellent reviews of equity theory and related research have been published in recent years (31, 50, 85). Pritchard (85) reviews equity theory research mainly with regard to performance and concludes that, although predictions with regard to *underpayment* seemed to have been generally supported, predictions about the effects of *overpayment* do not find convincing support. Pritchard presents two general extending assumptions, namely: (*a*) that feelings of inequity arise primarily out of a comparison of a person's input/outcome ratio to some internal standard, rather than out of a social comparison process; and (*b*) that an exchange relationship may have an effect on feelings of inequity depending upon where on an intimate-impersonal continuum this exchange relationship takes place and whether outcomes are determined by this exchange relationship or by some third party.

Pritchard's presentation can only be considered a promising beginning in clarifying and articulating the still vague and relatively unsophisticated nature of equity theory as a theory of motivation or satisfaction. These extensions of equity theory also present some exciting research ideas and possibilities for expanding the theory to incorporate other theoretical approaches such as Smith, Kendall & Hulin's (103) formulation regarding frame of reference. Leventhal, Weiss & Long's (51) research on the relationship between feelings of inequity and norms of social responsibility represents a further attempt to clarify equity theory.

Tornow (108) has tackled one of the major issues in equity theory needing clarification. Criticizing its lack of concern for individual difference, Tornow attempted to measure individual perceptions of ambiguous job characteristics as being either inputs or outcomes. His results, although not overly strong, do suggest that the main effects of underreward and overreward may be moderated by the degree to which individuals differ in their perceptions of the same ambiguous job elements.

Another approach which may help explain the affects of equity on productivity is provided by Korman's (47, 48) research on self-esteem and its relation to satisfaction and performance. Korman indicates that individuals are motivated to perform in a manner consistent with their self-image and that those situations that are in balance with a person's self-perceptions are perceived as most satisfying. Although Korman's hypotheses regarding work behavior appear to have some potential for elaborating issues in equity theory, VIE theory, and the "grand hypothesis" of the human relations theorists, they are stated in general terms and their theoretical utility is therefore rather difficult to evaluate at this time.

Goodman & Friedman (31) present an outstanding and up-to-date review of both the empirical research and the various theoretical issues underlying equity theory in its current state. Contrary to the conclusions of Pritchard (85), Lawler (50), and Wiener (115), who question the utility of some aspects of equity theory, Goodman & Friedman believe that, given certain clarifications and extensions as well as supporting empirical evidence on these issues, the utility of equity theory is quite satisfactory. Lawler (50) examines the effects of pay inequity on productivity primarily and compares equity theory with VIE theory predictions about motivation to produce. He concludes that: " . . . as far as the piecerate situations are concerned, [VIE theory] can explain the research results best if it includes equity as one of the factors that influences the valence of pay." For hourly compensation systems, Lawler feels that VIE theory can handle the existing data without reference to equity theory assumptions. However, since VIE theory and equity theory do make contradictory predictions, further research which tests competing hypotheses from these two theories is required (31).

Until the theoretical and methodological issues outlined in the recent reviews have been clarified, it will be difficult to determine whether equity theory is relevant to only one of many processes contributing to an individual's feelings about certain organizational rewards, as Lawler (50) suggests, or whether it represents a broadly useful theory of organizational behavior, as the Telly, French & Scott (107) research seems to indicate.

OVERVIEW OF PROCESS THEORIES

We have focused our discussion on the cognitive process theories because they have clearly had a much greater impact upon the literature of work motivation and satisfaction than have theories derived from the behavioristic tradition of psychology. The state of process theories in particular, and theories of motivation and satisfaction in general, is well described in the statement by Lawler that " . . . this field is not a mature one. It is suffering growing pains. The very fact that it is suffering these growing pains is at least evidence that it is alive and that growth is taking place (49, p. 224)."

In general, we find that process theories lack the articulation necessary for strong support. Even the more developed VIE models lack *precise* tests of the hypothesized relationships among the conceptual components. In addition, comparisons among the different process theories are made difficult by a confusing array of terms for similar constructs and by inadequate definitions of the concepts involved. Few attempts have been made to use the "strong inference" approach advocated by Platt (84) by testing competing hypotheses deriving from different theoretical models or to integrate different theoretical viewpoints. Since there is an abundance of theories, models, and general hypotheses, and since different theories tend to focus on different processes and behaviors, integration and competitive evaluation represent an important next step in research and theorizing.

Finally, we believe that there are two major shortcomings in the existing formulations of the various process theories. One is the fact that the role of the task as explicated by Hackman (34) has been one of the most uncharted areas in efforts to explain and understand behavior in organizations. Secondly, the effects of individual differences have not been given the attention that they obviously deserve and that writers such as Tornow (108) have advocated. Thus a researcher's delight (or nightmare) still lies ahead.

CONTENT THEORIES

We consider now those theories which place primary emphasis on particular motives or types of motives. Although not devoid of process aspects, these theories are distinguished by the fact that process considerations either are distinctly secondary or have emerged subsequent to the original formulations.

NEED HIERARCHY AND SELF-ACTUALIZATION

Historically the need hierarchy theory developed by Maslow has not been subjected to as extensive testing in the job situation as it should have been; on occasion there has been what can only be viewed as uncritical acceptance. In the period covered by this review there has been some improvement in this situation.

Evidence.—Wofford (118) finds, contrary to the Maslow formulation, that higher level needs may be related to job satisfaction even when lower level needs are not gratified. Thus the concept of a fixed hierarchy, with needs at higher levels emerging only when those at lower levels are gratified, continues to appear highly questionable.

Studies approaching need hierarchy theory from the viewpoint of content rather than process also raise serious questions. Factor analyses by Payne (82) and Roberts, Walter & Miles (88) have generally failed to yield groupings of items which match the categories of the Maslow typology. Among managers as well as factory workers the evidence does not support the idea that physiological, safety, social, ego and self-actualization needs are somehow inherent and basic. It is possible that these studies have not always used measures which accurately operationalize the variables of need hierarchy theory, but it is also true that the literature contains little by way of support. At this point in time the most appropriate conclusion appears to be either that need hierarchy theory is not supported by research evidence or that it has not been formulated with sufficient precision to permit adequate testing.

Research generated.—Based on a criterion of the amount of research stimulated, however, need hierarchy theory achieves a completely different status. Irrespective of its validity, the theory has generated a considerable amount of knowledge—primarily in relation to differences between cultures, occupations, and types of organizations. Many of the recent studies in this area have yielded replications of prior results, but there are some interesting new findings as well. The following are typical.

A study of blue collar workers in comparable Mexican and United States plants by Slocum, Topichak & Kuhn (101) produced quite different rankings of the Maslow needs in the two cultures. Furthermore, the Mexican operatives consistently had greater need satisfaction and placed more importance on the various needs, irrespective of level. A comparison of U.S. executives working in Europe with executives in the U.S. conducted by Ivancevich & Baker (44) also produced some sizable departures from the rankings need hierarchy theory would anticipate. On many of the needs those working in Europe proved to be less satisfied.

Ghiselli & Johnson (30) have compared organizations with tall and flat structures in terms of the degree to which need satisfactions relate to success. They find meaningful relationships only for higher order needs in flat organizations with large spans of control. Mitchell (72) has used the Maslow needs to investigate line-staff differences in the Air Force. He finds higher need satisfaction and fulfillment among line officers, but considerable variability within the staff category. These and other studies are indicative of the degree to which need hierarchy theory continues to be a stimulant to research dealing with organizational variables.

Related theories.—Several theories have been proposed as specific modifications or alternatives to Maslow's formulations. Thus, Alderfer (1) has advanced a theory which telescopes the need hierarchy into existence, relatedness, and growth needs. The hierarchical idea is retained, but the hierarchy is no longer strictly ordered, and the matter of the extent to which higher order need frustration may influence lower level needs is considered. Initial tests provide more support for this new theory than for either the Maslow formulations or for a simple need frustration hypothesis. The Alderfer theory represents a clear attempt to reformulate need hierarchy theory with a view to circumventing the specific refutations that have emerged from research. It appears to be the most promising version of the theory at the present time.

A related effort by Wolf (119) leads into the next theory to be considered. Wolf contends that the Herzberg two-factor theory errs in equating satisfaction with motivation. In essence he uses the Maslow formulations but collapses the need hierarchy into the two levels of the Herzberg theory and relates extrinsic factors to lower order needs and intrinsic factors to those at a higher level. Both the Maslow and Herzberg theories are viewed essentially as theories of job satisfaction; when motivation is added, various aspects of VIE theory are introduced.

Two-Factor Theory

Two reviews of research on two-factor theory point up the continuing controversy (7, 46). Bockman (7) is sympathetic and admits to an initial bias to Herzberg's views, concluding that his theory is generally misunderstood by its critics. The difference between the two sides is attributed to differences in what is being measured. King (46), on the other hand, considers the lack of an explicit statement of the theory as the major source of controversy. He presents five different versions that he finds either stated or implied by various researchers. Two of these are considered to be invalid due to a lack of supporting research; one is invalid because it reflects experimenter coding bias, and the remaining two have not been adequately tested. Thus, on balance, the theory comes off poorly at the hands of this second reviewer.

Evidence.—In a very recent series of studies the five versions of two-factor theory noted by King have all been put to test. In the most comprehensive of these studies Waters & Roach (112) find no support for any version of two-factor theory using female samples. However, analyses of the data from male samples do provide some support for the two weakest or most global versions of the theory.

On the other hand, it is clear from a paper by Grigaliunas & Herzberg (33) that the original author of the theory does not view rating scale measures, such as those used in the Waters & Roach research, as adequate to the intended purpose. Data are presented to show that such rating scale procedures introduce irrelevant items into the attitude measurement process and that unless the relevancy dimension and other sources of error are controlled, an adequate test of two-factor theory is not possible using rating scales. The original story-telling method is recommended, although techniques by which subjects exert an influence on what is rated would also seem acceptable.

Using the story-telling approach, Schneider & Locke (94) find that results favorable to the theory can be explained as an artifact of the method used to classify incidents. Thus, they view two-factor theory as an outgrowth of confusing events and agents rather than as an inevitable consequence of the story-telling method per se. They propose defensiveness, and specifically projection, as a major explanation of results favorable to the theory and show that with a logical classification system the story-telling procedure does not necessarily yield supportive results.

Research conducted by Bobbitt & Behling (6) appears on the surface to refute this defense mechanism explanation. However, as Locke (57) points out, the methodology used is such as to raise a serious question whether a true test of this hypothesis was in fact made. Clearly more research is needed in this area.

A study by Schwab & Heneman (97) employing the story-telling approach finds support for the theory when aggregate data are used, but when analyses of responses by *individuals* to favorable and unfavorable sequences were considered two-factor, theory was not supported. Additional negative evidence derives from the closely related study of Schwab, DeVitt & Cummings (96), which suggests that extension of the theory from job satisfaction to work motivation is not warranted because predicted performance effect relationships cannot be demonstrated.

Related theories.—In general we would agree with Campbell et al (8) that two-factor theory has now served its purpose and should be either altered or laid aside. Yet we feel that of these two alternatives a resort to revision and extension is preferable. Some very stimulating ideas are emerging out of such efforts.

Of the revisions, Hackman's (36) appears to move the shortest distance from the original formulations. However, he views those who derive satisfaction from work as primarily stimulation seekers and those who do not as emotional responders; this rather than thinking in terms of motivation seekers and hygiene seekers. Here he is very close to the Evans & McKee (23) formulations regarding Internals and Externals, and their results would appear to support his. In addition, Hackman develops a much more differentiated theory of work motivation than the original two-factor theory provided. Yet Hackman is far from providing a solution to the controversy surrounding two-factor theory, and his presentation is somewhat lacking in integration.

Soliman (105) advances a theory which introduces the organizational environment as a moderator variable in two-factor theory and provides some supporting data. In a highly need-satisfying environment, motivators are more powerful sources of satisfaction; in a need-depriving environment, hygiene factors are more powerful sources of the dissatisfaction. Furthermore, satisfaction/dissatisfaction is viewed as a unidimensional concept. In support of the Soliman view is Pennings' (83) finding that organizational units with high promotion rates are characterized by high intrinsic values and lower extrinsic values; the reverse is true in units with low promotion rates.

This tendency for intrinsic motivation to dominate where opportunity is greatest has been noted in other studies as well (78, 90, 117). Thus, Paine (78) finds that intrinsic factors are more important in the job choices of honors students than for regular students. Williamson & Karras (117) obtained much the same result from a comparison of female college students and female clerical workers. Saleh & Hyde (90) present additional comparisons which are subject to the same interpretation.

Another theoretical revision has been advanced by Wernimont (114), who argues that the controversy over two-factor theory is more appropriately solved on semantic and logical than on empirical grounds. In this formulation intrinsic and extrinsic variables are viewed as being in two separate domains. The former are feelings and the latter external situations. Thus if one is talking about job satisfaction, extrinsic and other situational factors must precede intrinsic and other intervening variables. Feelings *about* the situation are converted into the feelings *of* which are defined as intrinsic. This causal sequence has been obscured as a result of certain inherent characteristics of the language people must use to describe the sources of job attitudes.

JOB ENLARGEMENT

Two-factor theory has stimulated considerable research both of a methodological nature and with regard to the correlates of various motives and attitudes. It has also played a role in the advent of the job enlargement movement. The theory is that increased vertical, and in some cases also horizontal, job enlargement will result in increased intrinsic motivation which will be manifested in job behavior and satisfaction. According to Ford & Borgatta (27), the following factors are involved when jobs are enlarged: the work itself is interesting, the job is not wasteful of time and effort, there is no feeling of a need for more freedom in planning the job, a reasonable say in how the job is done exists, the job provides opportunities, the job provides feedback, the job is not too closely supervised, and it is worthwhile putting effort into the job.

Recent reviews of the job enlargement literature present a conflicting picture. Filley & House (24) conclude that positive results have been demonstrated for both division of labor and job enlargement, although vertical enlargement appears more potent than horizontal. Davis (15) interprets the job enlargement research favorably in a context of changing work values.

Evidence.—Strong arguments for job enlargement have been advanced by Ford (26), based on research in the Bell System, and by Myers (76), from experience at Texas Instruments. Although results are not uniformly positive and there are problems of design, much of the company-based research published in the recent period has been favorable to the job enlargement hypothesis. In this context a laboratory study by Maher (61) takes on particular interest. Performance generally was found to rise with increasing amounts of job enlargement, but satisfaction tended to exhibit a curvilinear pattern. It is apparent from this study that a number of factors can interact to determine the results of job enlargement studies and that control of unwanted variables is essential to valid attribution of causation.

This point is underlined even more strongly by the research of Bishop & Hill (5). They compared the consequences of job enlargement, change without enlargement, and no change but in a situation with contiguity to the changed jobs. The most important findings were that job enlargement had no greater influence on dependent variables than change without enlargement, and that those whose work was not changed experienced negative effects from the attention given to others in their environment.

Other research suggests that job enlargement can be carried too far. Sales (91, 92) presents evidence that role overload can contribute to the etiology of coronary disease. His laboratory research also indicates that although role overload increases productivity, this occurs at the expense of quality, and that tension increases while self-esteem decreases. There appear to be sizable individual differences in susceptibility to role overload. Combining these findings with prior evidence from studies of division of labor and job enlargement yields strong support for the view that there is an optimum job size which may vary considerably from one person to another.

Moderator relationships.—Research continues to be concerned with the rural-urban differential as one correlate of these individual differences. Thus Wild & Kempner (116) find that those from urban areas are more disposed to accept rationalized and paced work and thus by implication would be expected to respond less positively to job enlargement. Yet Shepard (100) presents data suggesting that alienation is not a mediating variable in the job size-job satisfaction relationship.

In view of the lack of conceptual clarity surrounding the alienation concept demonstrated by Seeman (98), it is fortunate that researchers have moved to the more precise specification of psychological moderators. The research in this area has been extensively reviewed by Hulin (40) and by Hackman & Lawler (35). The latter have also conducted a particularly significant investigation of their own. They have been able to demonstrate that the positive relationship between enlarged jobs (in terms of variety, autonomy, task identity, and feedback) and favorable outcomes (satisfaction, high quality work, and low absenteeism) is primarily a characteristic of those who desire higher order need satisfaction strongly. Thus, it would appear that individuals in whom such needs are dominant will be most likely to respond favorably to job enlargement. This motivational moderator appears to provide for more precise prediction than moderators of a sociological nature.

THEORIES OF OCCUPATION-RELATED MOTIVES

We will consider under this heading those theories that in their personnel applications have been formulated to apply primarily to specific occupational groups—entrepreneurship and economic development, management of bureaucracies, etc.

Achievement motivation and entrepreneurship.—The close relationship between achievement motivation and success in entrepreneurial activities continues to be documented. Wainer & Rubin (110) conducted a study of technically based firms in the Boston area and found achievement, but not power or affiliation motivation, closely associated with company growth rates. Hundal (41) found achievement motivation closely associated with the growth rate of small firms in India.

In a series of studies, McClelland & Winter (62) have attempted to inculcate achievement motivation using management development procedures, and to measure the consequences in terms of subsequent entrepreneurial success. Although not all the efforts reported were successful and the research program was beset by many difficulties, some evidence in support of the underlying theory was obtained. In the major study achievement motivation was increased by training. In addition, those who underwent training were subsequently more active in stimulating business growth and in new economic ventures than those who did not. This type of entrepreneurial activity was particularly pronounced where opportunity was greatest, i.e. where the individual was in fact in charge of a business.

The dynamics of achievement motivation.—Additional studies have been devoted to understanding the dynamics of achievement motivation, and thus elaborating the underlying theory, and to exploring interactions with leadership styles. Weiner & Kukla (113) present support for the view that individuals high on achievement motivation approach achievement-related activities and persist in them longer because they tend to ascribe success and failure to their own efforts and thus experience greater internal rewards and punishments. The tendency to seek tasks of intermediate difficulty is seen as resulting from the fact that such tasks yield more information about one's capabilities. Thus Weiner & Kukla reinterpret aspects of achievement motivation theory in terms of attribution theory.

In addition, achievement motivation theory has been extended to take into account the effects of expected future outcomes (and accordingly allied to VIE theory). Thus Raynor (86) found that students with high achievement motivation received higher grades when the grade was viewed as instrumental to career success than when it was not. Other research by Raynor & Rubin (87) also supports this position that achievement motivation is more likely to be translated into achievement behavior when that behavior is viewed as a contingent condition for later success. Considerations of this kind may explain the negligible relationships between achievement motivation and outcome variables that Patchen (81) noted in the TVA organization.

Research relating achievement motivation to leadership styles and organizational climate continues. Misumi & Seki (67) found that in groups constituted of individuals with high achievement need a strong balanced supervisory emphasis on both performance and group maintenance considerations was most effective and a laissez-faire approach least effective. In low achievement motivation groups a strongly performance oriented style was most effective. Donley & Winter (17) have shown interesting relationships between the achievement and power motives of U.S. presidents, as measured from inaugural addresses, and their subsequent style in office.

Role-motivation theory.—Gantz, Erickson & Stephenson (28) provide added evidence of the construct validity of the concept of managerial motivation as defined by the role-motivation theory. In addition, managerial motivation so defined continues to show good correlations with measures of managerial effectiveness. Miner (63) presents data which indicate the theory is applicable primarily within large bureaucratic organizations. While managerial motivation has consistently related to success in these organizations it has not proved to be important in smaller professional and semiprofessional organizations. The same paper deals at some length with the subject of changes in the level of managerial motivation over the decade of the 1960s among college students. The data suggest that a major decline in such motivation has occurred.

A study conducted by Miner & Smith (66) provides further information bearing on role-motivation theory. It appears that managerial motivation is tied to managerial career choice only very weakly among undergraudate students; at the graduate level, however, those with the intent to pursue managerial careers have much stronger managerial motivation than those who do not. The findings are consistent with the hypothesis that strong motives tend to become attached to specific, relevant career choices only as the individual learns more regarding alternative vocational possibilities.

OVERVIEW OF CONTENT THEORIES

The content theories have clearly generated a great deal of research in the past few years. This represents a major strength. On the other hand, this research has been rather fragmented with each theory establishing its own domain and often its own methods as well. As a result the "value added" from the effort put forth has been less than might be desired. Only in the case of need hierarchy theory and two-factor theory has any integration emerged and that has been both limited and very recent.

There is a definite need at this stage for a more comprehensive theory which pulls the limited domain theories together. A listing of some motives which appear to have significance for organizational behavior now exists. What seems needed is a comprehensive theory of organizational and individual functioning which deals with the interrelationships among and dynamics of needs such as those for self-actualization, security, intrinsic satisfaction, achievement, power, and the others. In addition to motives considered by the content theorists, others which appear to be important in particular types of organizations might be considered for inclusion in such a formulation. Thus Ghiselli's (29) findings regarding the significance of the traits of self-assurance and decisiveness in managerial work suggest a motivational base; Miner (65) presents data which seem to indicate that eliteness motivation may be an important factor in certain management consulting organizations. One solution to the problem of understanding the significance of different motives for behavior is the integration of the content and process approaches as Lawler (50) and Ryan (89) have attempted to do.

An alternative approach would be to shift the research emphasis away from the specific needs and motives of most content theories to the motivational requirements of tasks and to informal and formal job role requirements. Thus the major concern would be with the sum total of motivational inputs needed to satisfy job requirements. Theories of occupation-related motives have made progress along these lines insofar as the entrepreneurial role and the role of manger in a bureaucracy are concerned. If this approach can be extended further to cover a whole network of key jobs in varying organizational contexts, the possibility exists that a base for meaningful organizational change can be developed long before the total complexity of specific human motives is understood. What might well emerge is a highly parsimonious but comprehensive theory which takes job requirements rather than human motives as its starting point and which thus capitalizes on the fact that *personnel* attitudes and motivation are only part of a much broader domain of psychological study.

Whatever the approach to comprehensive theory formulation, the study of personnel attitudes and motivation must be concerned with the organizational context in which manifestation occurs. Such organizational factors as climate, status congruity, reward and value structures, role conflict and ambiguity, and the clarity of behavior models all appear to relate to the degree to which there is integration or consistency of reinforcement in the organizational environment (64). If this matter of the degree of integration of climates, value structures, role structures, status relationships, or whatever one wishes to call them is not incorporated in our more comprehensive theories, it seems unlikely that the results of laboratory studies will find consistent replication in the organizational setting.

LITERATURE CITED

1. Alderfer, C. P. 1969. An empirical test of a new theory of human needs. *Organ. Behav. Hum. Perform.* 4:142–75
2. Arvey, R. D., Dunnette, M. D. 1970. Task performance as a function of perceived effort-performance and performance-reward contingencies. *ONR Tech. Rep. 4003*
3. Atkinson, J. W., Feather, N. T. 1966. *A Theory of Achievement Motivation.* New York: Wiley. 392 pp.
4. Bass, A. R., Rosen, H., Hill, J. W. 1970. The prediction of complex organizational behavior: A comparison of decision theory with more traditional techniques. *Organ. Behav. Hum. Perform.* 5: 449–62
5. Bishop, R. C., Hill, J. W. 1971. Effects of job enlargement and job change on contiguous but nonmanipulated jobs as a function of workers' status. *J. Appl. Psychol.* 55:175–81
6. Bobbitt, H. R., Behling, O. 1972. Defense mechanisms as an alternate explanation of Herzberg's motivator-hygiene results. *J. Appl. Psychol.* 56:24–27
7. Bockman, V. M. 1971. The Herzberg controversy. *Personnel Psychol.* 24: 155–89
8. Campbell, J. P., Dunnette, M. D., Lawler, E. E., Weick, K. E. 1970. *Managerial Behavior, Performance, and Effectiveness.* New York: McGraw-Hill. 546 pp.
9. Carroll, S. J., Tosi, H. L. 1970. Goal characteristics and personality factors in a management-by-objectives program. *Admin. Sci. Quart.* 15:295–305
10. Cherrington, D. J., Reitz, H. J., Scott, W. E. 1971. Effects of contingent and noncontingent reward on the relationship between satisfaction and task performance. *J. Appl. Psychol.* 55:531–36
11. Cummings, L. L., Schwab, D. P. 1972. An evaluation of theories linking employee satisfaction and task performance. *Ind. Relat.* 11. In press
12. Cummings, L. L., Schwab, D. P., Rosen, M. 1971. Performance and knowledge of results as determinants of goal setting. *J. Appl. Psychol.* 55:526–30
13. Dachler, H. P., Hulin, C. L. 1969. A reconsideration of the relationship between satisfaction and judged importance of environmental and job characteristics. *Organ. Behav. Hum. Perform.* 4:252–66
14. Dachler, H. P., Mobley, W. H. 1971. An interorganizational study of the relationship between attitudes, motivation, and production behavior. Univ. Maryland Tech. Rep. 71-1
15. Davis, L. E. 1971. Job satisfaction research: The post-industrial view. *Ind. Relat.* 10:176–93
16. Deci, E. L., Vroom, V. H. 1971. The stability of post-decision dissonance: A follow-up study of the job attitudes of business school graduates. *Organ. Behav. Hum. Perform.* 6:36–49
17. Donley, R. E., Winter, D. G. 1970. Measuring the motives of public officials at a distance: An exploratory study of American presidents. *Behav. Sci.* 15:227–36
18. Dulany, D. E. 1968. Awareness, rules, and propositional control: A confrontation with S-R behavior theory. In *Verbal Behavior and General Behavior Theory*, ed. T. R. Dixon, D. L. Horton, 340–87. Englewood Cliffs, N. J.: Prentice-Hall. 596 pp.
19. Dunbar, R. L. M. 1971. Budgeting for control. *Admin. Sci. Quart.* 16:88–96
20. Einhorn, H. J. 1970. The use of nonlinear, noncompensatory models in decision making. *Psychol. Bull.* 73:221–30
21. Einhorn, H. J. 1971. Use of nonlinear, noncompensatory models as a function of task and amount of information. *Organ. Behav. Hum. Perform.* 6:1–27
22. Evans, M. G. 1970. The effects of supervisory behavior on the path-goal relationship. *Organ. Behav. Hum. Perform.* 5:277–98
23. Evans, M. G., McKee, D. 1970. Some effects of internal versus external orientations upon the relationships between various aspects of job satisfaction. *J. Bus. Admin.* 2:17–24
24. Filley, A. C., House, R. J. 1969. *Managerial Process and Organizational Behavior.* Glenview, Ill.: Scott, Foresman. 499 pp.

25. Fishbein, M., Ajzen, I. 1972. Attitudes and opinions. *Ann. Rev. Psychol.* 23:487–544
26. Ford, R. N. 1969. *Motivation Through the Work Itself.* New York: Am. Manage. Assoc. 267 pp.
27. Ford, R. N., Borgatta, E. F. 1970. Satisfaction with the work itself. *J. Appl. Psychol.* 54:128–34
28. Gantz, B. S., Erickson, C. O., Stephenson, R. W. 1971. Measuring the motivation to manage in a research and development population. *Proc. 79th Ann. Conv. APA* 6:129–30
29. Ghiselli, E. E. 1971. *Explorations in Managerial Talent.* Pacific Palisades, Calif.: Goodyear. 166 pp.
30. Ghiselli, E. E., Johnson, D. A. 1970. Need satisfaction, managerial success, and organizational structure. *Personnel Psychol.* 23:569–76
31. Goodman, P. S., Friedman, A. 1971. An examination of Adam's theory of inequity. *Admin. Sci. Quart.* 16: 271–86
32. Graen, G. B. 1969. Instrumentality theory of work motivation: Some experimental results and suggested modifications. *J. Appl. Psychol. Monogr.* 53 (2):Pt. 2. 25 pp.
33. Grigaliunas, B. S., Herzberg, F. 1971. Relevancy in the test of motivator-hygiene theory. *J. Appl. Psychol.* 55:73–79
34. Hackman, J. R. 1969. Toward understanding the role of tasks in behavioral research. *Acta Psychol.* 31:97–128
35. Hackman, J. R., Lawler, E. E. 1971. Employee reactions to job characteristics. *J. Appl. Psychol.* 55: 259–86
36. Hackman, R. C. 1969. *The Motivated Working Adult.* New York: Am. Manage. Assoc. 206 pp.
37. Heneman, H. G. III, Schwab, D. P. 1972. An evaluation of research on expectancy theory predictions of employee performance. *Psychol. Bull.* 78:1–9
38. Hinrichs, J. R. 1970. Psychology of men at work. *Ann. Rev. Psychol.* 21: 519–54
39. House, R. J. 1971. A path goal theory of leader effectiveness. *Admin. Sci. Quart.* 16:321–38
40. Hulin, C. L. 1971. Individual differences and job enrichment—The case against general treatments. See Ref. 61, 159–91
41. Hundal, P. S. 1971. A study of entrepreneurial motivation: Comparison of fast- and slow-progressing small-scale industrial entrepreneurs in Punjab, India. *J. Appl. Psychol.* 55:317–23
42. Hunt, J. G., Hill, J. W. 1969. The new look in motivational theory for organizational research. *Hum. Organ.* 28:100–9
43. Ilgen, D. R. 1971. Satisfaction with performance as a function of the initial level of expected performance and the deviation from expectations. *Organ. Behav. Hum. Perform.* 6:345–61
44. Ivancevich, J. M., Baker, J. C. 1970. A comparative study of the satisfactions of domestic United States' managers and overseas United States' managers. *Acad. Manage. J.* 13:69–77
45. Ivancevich, J. M., Donnelly, J. H., Lyon, H. L. 1970. A study of the impact of management by objectives on perceived need satisfaction. *Personnel Psychol.* 23:139–51
46. King, N. 1970. Clarification and evaluation of the two-factor theory of job satisfaction. *Psychol. Bull.* 74:18–31
47. Korman, A. K. 1970. Toward an hypothesis of work motivation. *J. Appl. Psychol.* 54:31–41
48. Korman, A. K. 1971. Organizational achievement, aggression and creativity: Some suggestions toward an integrated theory. *Organ. Behav. Hum. Perform.* 6:593–613
49. Lawler, E. E. 1970. Job attitudes and employee motivation: Theory, research, and practice. *Personnel Psychol.* 23:223–37
50. Lawler, E. E. 1971. *Pay and Organizational Effectiveness: A Psychological View.* New York: McGraw-Hill. 318 pp.
51. Leventhal, G. S., Weiss, T., Long, G. 1969. Equity, reciprocity, and reallocating rewards in the dyad. *J. Pers. Soc. Psychol.* 13:300–5
52. Lichtman, C. M., Hunt, R. G. 1971. Personality and organization theory: A review of some conceptual literature. *Psychol. Bull.* 76:271–94
53. Lifter, M. L., Bass, A. R., Nussbaum, H. 1971. Effort expenditure and job performance of line and staff personnel. *Organ. Behav. Hum. Perform.* 6:501–15
54. Locke, E. A. 1969. What is job satis-

faction? *Organ. Behav. Hum. Perform.* 4:309–36

55. Ibid 1970. Job satisfaction and job performance: A theoretical analysis. 5:484–500
56. Locke, E. A. 1970. The supervisor as "motivator": His influence on goal setting. In *Managing for Accomplishment*, ed. B. M. Bass, R. Cooper, J. A. Haas, 57–67. Lexington, Mass.: Heath. 317 pp.
57. Locke, E. A. 1972. In defense of defense mechanisms: Some comments on Bobbitt and Behling. *J. Appl. Psychol.* 56:297–98
58. Locke, E. A., Bryan, J. F. 1969. Knowledge of score and goal level as determinants of work rate. *J. Appl. Psychol.* 53:59–65
59. Locke, E. A., Bryan, J. F. 1969. The directing function of goals in task performance. *Organ. Behav. Hum. Perform.* 4:35–42
60. Locke, E. A., Cartledge, N., Knerr, C. S. 1970. Studies of the relationship between satisfaction, goal-setting, and performance. *Organ. Behav. Hum. Perform.* 5:135–58
61. Maher, J. R., Ed. 1971. Job enrichment, performance and morale in a simulated factory. *New Perspectives in Job Enrichment*, 35–53. New York: Van Nostrand Reinhold. 226 pp.
62. McClelland, D. C., Winter, D. G. 1969. *Motivating Economic Achievement*. New York: Free Press. 409 pp.
63. Miner, J. B. 1971. Changes in student attitudes toward bureaucratic role prescriptions during the 1960's. *Admin. Sci. Quart.* 16:351–64
64. Miner, J. B. 1971. *Management Theory*. New York: Macmillan. 168 pp.
65. Miner, J. B. 1971. Success in management consulting and the concept of eliteness motivation. *Acad. Manage. J.* 14:367–78
66. Miner, J. B., Smith, N. R. 1969. Managerial talent among undergraduate and graduate business students. *Personnel Guid. J.* 47: 995–1000
67. Misumi, J., Seki, F. 1971. Effects of achievement motivation on the effectiveness of leadership patterns. *Admin. Sci. Quart.* 16:51–59
68. Mitchell, T. R. 1972. Instrumentality theories: Conceptual and methodological problems. *J. Suppl. Abstr. Serv.* 2:37
69. Mitchell, T. R., Albright, D. 1972. Expectancy theory predictions of job satisfaction, job effort, job performance, and retention of naval aviation officers. *Organ. Behav. Hum. Perform.* 8:1–20
70. Mitchell, T. R., Biglan, A. 1971. Instrumentality theories: Current uses in psychology. *Psychol. Bull.* 76:432–54
71. Mitchell, T. R., Nebeker, D. M. 1971. Expectancy theory predictions of academic performance and satisfaction. *ONR Tech. Rep. 71-29*
72. Mitchell, V. F. 1970. Need satisfactions of military commanders and staff. *J. Appl. Psychol.* 54:282–87
73. Mitchell, V. F. 1972. Expectancy theories of managerial motivation. *Acad. Manage. Proc.* 31:210–20
74. Mobley, W. H. 1971. *An interorganizational test of a task-goal expectancy model of work motivation and performance*. PhD thesis. Univ. Maryland, College Park. 190 pp.
75. Mobley, W. H., Locke, E. A. 1970. The relationship of value importance to satisfaction. *Organ. Behav. Hum. Perform.* 5:463–83
76. Myers, M. S. 1970. *Every Employee a Manager*. New York: McGraw-Hill. 233 pp.
77. Nord, W. R. 1969. Beyond the teaching machine: The neglected area of operant conditioning in the theory and practice of management. *Organ. Behav. Hum. Perform.* 4: 375–401
78. Paine, F. T. 1969. What do better college students want from their jobs? *Personnel Admin.* 32 (2): 26–29
79. Pallone, N. J., Hurley, R. B., Rickard, F. S. 1971. Emphasis in job satisfaction research: 1968–69. *J. Vocat. Behav.* 1:11–28
80. Pallone, N. J., Rickard, F. S., Hurley, R. B. 1970. Job satisfaction research of 1966–67. *Personnel Guid. J.* 48:469–78
81. Patchen, M. 1970. *Participation, Achievement, and Involvement on the Job.* Englewood Cliffs, N. J.: Prentice-Hall. 285 pp.
82. Payne, R. 1970. Factor analysis of a Maslow-type need satisfaction questionnaire. *Personnel Psychol.* 23:251–68
83. Pennings, J. M. 1970. Work value systems of white-collar workers. *Admin. Sci. Quart.* 15:397–405

84. Platt, I. R. 1964. Strong inference. *Science* 146:346–52
85. Pritchard, R. D. 1969. Equity theory: A review and critique. *Organ. Behav. Hum. Perform.* 4:176–211
86. Raynor, J. O. 1970. Relationships between achievement-related motives, future orientation and academic performance. *J. Pers. Soc. Psychol.* 15:28–33
87. Raynor, J. O., Rubin, I. S. 1971. Effects of achievement motivation and future orientation on level of performance. *J. Pers. Soc. Psychol.* 17:36–41
88. Roberts, K. H., Walter, G. A., Miles, R. E. 1971. A factor analytic study of job satisfaction items designed to measure Maslow need categories. *Personnel Psychol.* 24: 205–20
89. Ryan, T. A. 1970. *Intentional Behavior: An Approach to Human Motivation.* New York: Ronald. 590 pp.
90. Saleh, S. D., Hyde, J. 1969. Intrinsic vs extrinsic orientation and job satisfaction. *Occup. Psychol.* 43: 47–53
91. Sales, S. M. 1969. Organizational role as a risk factor in coronary disease. *Admin. Sci. Quart.* 14: 325–36
92. Sales, S. M. 1970. Some effects of role overload and role underload. *Organ. Behav. Hum. Perform.* 5: 592–608
93. Schneider, B., Olson, L. K. 1970. Effort as a correlate of organizational reward system and individual values. *Personnel Psychol.* 23: 313–26
94. Schneider, J., Locke, E. A. 1971. A critique of Herzberg's incident classification system and a suggested revision. *Organ. Behav. Hum. Perform.* 6:441–57
95. Schuster, J. R., Clark, B., Rogers, M. 1971. Testing portions of the Porter and Lawler model regarding the motivational role of pay. *J. Appl. Psychol.* 55:187–95
96. Schwab, D. P., DeVitt, H. W., Cummings, L. L. 1971. A test of the adequacy of the two-factor theory as a predictor of self-report performance effects. *Personnel Psychol.* 24:293–303
97. Schwab, D. P., Heneman, H. G. III 1970. Aggregate and individual predictability of the two-factor theory of job satisfaction. *Personnel Psychol.* 23:55–66
98. Seeman, M. 1971. The urban alienations: Some dubious theses from Marx to Marcuse. *J. Pers. Soc. Psychol.* 19:135–43
99. Sheard, J. L. 1970. Intrasubject prediction of preferences for organization types. *J. Appl. Psychol.* 54: 248–52
100. Shepard, J. M. 1970. Functional specialization, alienation, and job satisfaction. *Ind. Labor Relat. Rev.* 23:207–19
101. Slocum, J. W., Topichak, P. M., Kuhn, D. G. 1971. A cross-cultural study of need satisfaction and need importance for operative employees. *Personnel Psychol.* 24: 435–45
102. Slovic, P., Lichtenstein, S. 1971. Comparison of Bayesian and regression approaches to the study of information processing in judgment. *Organ. Behav. Hum. Perform.* 6:649–744
103. Smith, P. C., Kendall, L. M., Hulin, C. L. 1969. *The Measurement of Satisfaction in Work and Retirement.* Chicago: Rand McNally. 186 pp.
104. Sobel, R. S. 1971. Tests of preperformance and post-performance models of satisfaction with outcomes. *J. Pers. Soc. Psychol.* 19: 213–21
105. Soliman, H. M. 1970. Motivation-hygiene theory of job attitudes: An empirical investigation and an attempt to reconcile both the one- and the two-factor theories of job attitudes. *J. Appl. Psychol.* 54:452–61
106. Steiner, I. D. 1970. Perceived freedom. In *Advances in Experimental Social Psychology*, ed. L. Berkowitz, 5:187–248. New York: Academic. 392 pp.
107. Telly, C. S., French, W. L., Scott, W. G. 1971. The relationship of inequity to turnover among hourly workers. *Admin. Sci. Quart.* 16: 164–72
108. Tornow, W. W. 1971. The development and application of an input-outcome moderator test on the perception and reduction of inequity. *Organ. Behav. Hum. Perform.* 6:614–38
109. Viteles, M. S. 1969. The two faces of applied psychology. *Int. Rev. Appl. Psychol.* 18:5–10

110. Wainer, H. A., Rubin, I. M. 1969. Motivation of research and development entrepreneurs. *J. Appl. Psychol.* 53:178–84

111. Wanous, J. P. 1971. Occupational preferences: Perceptions of valence and instrumentality, and objective data. *Exp. Publ. Syst.* Ms. No. 366-2

112. Waters, L. K., Roach, D. 1971. The two-factor theories of job satisfaction: Empirical tests for four samples of insurance company employees. *Personnel Psychol.* 24: 697–705

113. Weiner, B., Kukla, A. 1970. An attributional analysis of achievement motivation. *J. Pers. Soc. Psychol.* 15:1–20

114. Wernimont, P. F. 1972. A systems view of job satisfaction. *J. Appl. Psychol.* 56:173–76

115. Wiener, Y. 1970. The effects of task and ego-oriented performance on two kinds of overcompensation inequity. *Organ. Behav. Hum. Perform.* 5:191–208

116. Wild, R., Kempner, T. 1972. Influence of community and plant characteristics on job attitudes of manual workers. *J. Appl. Psychol.* 56:106–13

117. Williamson, T. R., Karras, E. J. 1970. Job satisfaction variables among female clerical workers. *J. Appl. Psychol.* 54:343–46

118. Wofford, J. C. 1971. The motivational bases of job satisfaction and job performance. *Personnel Psychol.* 24:501–18

119. Wolf, M. G. 1970. Need gratification theory: A theoretical reformulation of job satisfaction/dissatisfaction and job motivation. *J. Appl. Psychol.* 54:87–94

120. Yukl, G., Wexley, K. N., Seymore, J. D. 1972. Effectiveness of pay incentives under variable ratio and continuous reinforcement schedules. *J. Appl. Psychol.* 56:19–23

121. Zander, A. 1971. *Motives and Goals in Groups*. New York: Academic. 211 pp.

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ENVIRONMENTAL PSYCHOLOGY

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Scientific study of the interplay between human behavior and its environmental settings has gathered considerable momentum during the last decade, certainly enough to warrant its present initial treatment in this review series. The current intellectual vitality of this research area derives in part from its lively and thoroughgoing multidisciplinary character. In addition to psychologists, researchers in geography, environmental design and planning (architecture, urban design, landscape architecture, regional planning), natural resources management, political science, sociology, anthropology, and engineering have contributed scientific findings and have developed its scholarly apparatus of research conferences, associations, newsletters, journals, reviews and collected readings. The proceedings of two conferences held at the University of Utah (16, 247) and three conferences sponsored in part by the Environmental Design Research Association (EDRA) (13, 175, 220) form an important series in this country, while two significant conferences were held in Great Britain in 1969 and 1970 (45, 118). As a supplement to existing journals in the various disciplines, two recent publications, *Environment and Behavior* (268) and *Human Ecology* (254), serve an archival function for research reports in this field. The newsletters, *Man-Environment Systems*, issued by the Association for the Study of Man-Environment Relations (ASMER) in this country, and *Architectural Psychology*, issued in Great Britain, also facilitate communication of multidisciplinary endeavors (14, 120).

In an inherently and demonstratively multidisciplinary field, the matter of intellectual boundaries and labels offers recurrent, tantalizing, but only marginally important issues. In the present case, a general term, e.g. the study of man-environment relations, seems likely to be adopted for the field as a whole, while distinctive local terms may be employed within each discipline. For example, behavioral geography and psychogeography have been used by geographers in designating this area to colleagues within their discipline. Within psychology, the term architectural psychology has been employed, especially in Great Britain, by psychologists and research architects studying behavioral phenomena related to the built environment, while ecological psychology is associated with the pioneering theoretical perspective of Roger G. Barker and his associates (19). Environmental psychology seems to be useful as an inclusive, theoretically neutral term.

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In 1970, a comprehensive review of environmental psychology and a major collection of readings appeared (68, 202). The present review will provide a context of earlier contributions but will focus upon work appearing in the period from 1969 through early 1972. The selection of topics is illustrative but probably not inclusive.

Environmental assessment.—The novel value of man-environment studies for such professionals as architects, environmental planners, and natural resources managers lies in its systematic analysis of the human behavior that occurs in and responds to the environmental settings they plan, design, and manage. For psychologists, its distinctive attraction is just the opposite, namely, its serious attention to the environmental contexts of human behavior. Indeed, a taxonomic interest in the descriptive properties of places is a prerequisite to substantive research on man-environment relations (10, 88, 191, 225, 226). A recent review (69) identified five levels of environmental assessment. First, the physical-spatial properties of places can be assessed. For example, Shafer & Thompson (230) related 40 descriptive dimensions of Adirondack campsites (e.g. distance to lakeshore, number of white birches) to their frequency of use. Second, the organization of material artifacts in places can be assessed. Using the Living Room Check List, Laumann & House (143) assessed the contents of over 800 living rooms and, by smallest space analysis, identified a social class dimension and a traditional-versus-modern stylistic dimension. Third, the traits of places can be assessed by human observers. Adjective check lists, bipolar rating scales, and Q-sort decks are being developed to permit observers to record their impressions of places in quick, comparable and comprehensive ways (47, 69, 119, 236, 248, 275). Factor analysis of environmental rating scales (115, 129, 180, 224, 269) have yielded several competing arrays of fundamental environmental dimensions. The application of multidimensional scaling techniques is also being explored (34, 195). Fourth, the enduring behavioral attributes of places can be assessed. The analysis of activity patterns can yield a comparison of places on the basis of the relative frequency with which types of activities occur in them (19, 129). Fifth, the institutional attributes of places can be assessed. Following the model of Stern's studies (241) of educational institutions, Moos and his associates (178, 181) have developed the Ward Atmosphere Scales, which assess twelve dimensions, including spontaneity, order, practicality, and affiliation.

Environmental perception.—Just as environmental assessment has its parallel in personality assessment, the study of environmental perception is analogous to research on person perception, particularly in its focus upon the psychological and environmental factors which affect the impressions observers form of places and in its broad use of the term perception (2, 69, 98, 116, 216). The effect of cultural influences upon environmental perception has received considerable attention in recent geographical writings (98, 216). One well-sustained research program has examined the relationship of observer characteristics (e.g. previous experience, personality) and environmental variations (e.g. frequency of floods per site) to perceptions of natural hazards (41, 95, 130). Employing the technique of standard walks in several cities in this country, Lowenthal (155, 156) has related observer characteristics to descriptive impressions of the urban environment. Some research has tested the widespread assumption that environmental designers differ from laymen (and clients) in their perception of the built environment (44, 114, 141) but apparently no study has explored the consequences, if any, that such differences may entail. Environmental settings can be presented to observers either directly (e.g. via a standard tour, a long-term residence) or indirectly by means of simulation techniques (e.g. films, photographs, models, videotapes, computer graphics). The complex task of appraising the degree to which each mode of simulation approximates response to direct presentations is currently under way (51, 80, 123, 142, 224, 274). The effects of relative complexity upon environmental perception and evaluation continues to interest psychologists and designers (128, 172, 203, 204, 271).

Cognitive representation of the large-scale environment.—In his *Image of the City*, Lynch (157) sought techniques for examining the relationship between the physical form of urban areas and inhabitants' images of them. His work also brought to life the general psychological question of how persons conceptualize the large-scale physical environment that cannot be seen all at once, from a single vantage point (35, 240). Although the map-sketch has become a popular technique, it must be supplemented by other indices (e.g. model arrangements, distance estimates, verbal descriptions, way-finding tasks) in converging upon the nature of cognitive representations (62, 99, 138, 147, 148, 240). The theories of cognitive development formulated by Piaget and Werner are useful in understanding the ontogenesis of topographic representations (109, 144, 159). In this regard, the finding that children as young as 5 years can interpret aerial photographs, and thus perform the mapping transformations of scale reduction and projective rotation, is provocative (35). By examining the map-sketches and verbal descriptions rendered by individuals at intervals along a walking tour through an unfamiliar city, Gittens (94) has initiated study of the microgenesis of topographic representations. The role of cognitive styles is suggested by the observed types of map-sketches (e.g. route or sequential maps; survey or spatial maps) (11, 109); however, this lead has not yet been pursued. Social class and sex-role differences, perhaps mediated by variations in the physical and social orbits of activity routines, are being examined as antecedent factors in the attainment of comprehensive cognitive representations of the urban environment (188, 189).

Personality and the environment.—Environmental psychology seems destined to extend the scope of personality research in at least two ways. First, it is contributing new techniques for assessing environmental dispositions, a heretofore neglected array of personality attributes (63, 67). The preliminary form of the Environmental Response Inventory (165) attempts to assess such dispositions as pastoralism, urbanism, sensation-seeking, abstract conservationism, and environmental adaptation. The Environmental Personality Inventory (237) seeks to measure sensitivity to the environment, control over the environment, mobility, and environmental risk-taking. Several scales have been developed to assess stimulus-seeking and similar dispositions (1, 162, 196, 280). Other recently introduced devices include the Wildernism-Urbanism Scale (112), the Privacy Preference Scales (160, 161), the Mechanization Scale (97), and the Attitudes about Wildlife Q-Sort Deck (82). An attempt has been made to modify the Rosenzweig Picture-Frustration Test as a means of assessing reactions to natural and social hazards (18). Analysis of TAT and sentence completion protocols have suggested styles of coping with two kinds of hazards: tornadoes (231) and sudden storms in drought regions (232).

Second, the basic paradigm of personality assessment research is being applied to the task of understanding and forecasting significant environmental behaviors and outcomes such as outdoor recreational activities, spatial behavior, adjustment to natural hazards, and status as various kinds of environmental decision-maker. Schiff (222) is relating locus of control and sensation-seeking to adoption of adjustments to natural hazards. The Environmental Response Inventory has been used in comparing national forest managers and users and in identifying subtypes of users (199). The Wildernism-Urbanism Scale has been related to preferences for management policies in national forests (112). Personality correlates of personal space measures have been sought (79, 209).

Environmental decision-making.—Human behavior plays an important role as an antecedent factor in transformations of the physical environment. The behavior of every individual has some impact upon the environment, but in contemporary society, environmental decision-making is also structured along professional and institutional lines. An important impetus of current research is the oft-voiced assertion that the social and behavioral patterns which currently constitute planning, designing, and managing the environment must be examined, appraised, and probably altered (70, 121, 234). One direction of research is testing the subsidiary hypothesis that professional environmentalists differ from laymen in their attitudes, beliefs, and perceptions of the environment (9, 44, 113, 114), while other research is delineating the distinctive personality and social characteristics of various kinds of environmental decision-makers (24, 43, 64, 107, 243). Considering the intricate network of participants and modes of participation in environmental decision-making throughout modern technological societies, the empirical analysis of differences between decision-makers and their clients and among types of decision-makers represents a formidable task. Thus far the effort has been rather scattered and fragmentary. Furthermore, the possible functional consequences of such differences for the decision-making process and for human behavior in the environment have not been examined. One mechanism for organizing research is to survey all types of decision-makers within a given environmental setting. Costantini & Hanf (60) have undertaken a study of this scope within the Lake Tahoe Basin in California. Another approach focuses upon behavioral factors in the design and planning process, including the implicit and explicit assumptions made about man-environment relations and the influence of personality and cognitive factors in the generation of design solutions (59, 90, 152, 174, 176, 228). Finally, the ways in which laymen become involved in decision-making and the means and consequences of expanding their level of participation are receiving attention (17, 36, 51).

Public attitudes toward the environment.—Environmental attitudes in this country and perhaps in others seem to have entered into a dynamic phase, highlighted by Earth Day in 1970 (91, 229). In recent years, a split within the conservation movement between the utilitarian-'wise use' orientation and the appreciative-preservationist orientation was followed by the broader environmental movement, with its expanded concern encompassing air and water pollution and overpopulation (108, 183). Use of wilderness areas and membership in conservation organizations appear related to upper middle class status, although it is not evident that the latter finding holds for local conservation groups as well as national organizations (108, 112). General environmental concern is positively related to educational level, and rather than bridging political cleavages, may be related to liberal views (60, 76, 247, 251). The rapidly proliferating programs in environmental education offer promising contexts for studying the nature and antecedents of environmental beliefs and attitudes (117, 246). Several studies of public attitudes and perceptions of air, water, and noise pollution have been reported (15, 187, 217). In a period of rapidly shifting public opinion and the formation of new environmental interest groups, attitude surveys may enlighten policy makers about the state of their constituency and the likely reaction to large-scale regional schemes such as water development plans and transportation projects (259). However, the limits to their usefulness have also been noted: declared attitudes may not predict other significant behaviors; decision networks actually involve the interaction of functional interest groups rather than an undifferentiated public opinion (187, 259). Furthermore, as White wisely observes (259), because the actual consequences and side-effects of major environmental projects are rarely studied, public judgments (but also expert appraisals) of proposed projects must necessarily be speculative. Until large-scale environmental transformations are treated as experiments, this situation will not change

The quality of the sensory environment.—Engen (81) has reviewed issues in the use of the sense of smell in appraising environmental quality. Using a mobile odor laboratory for field experiments on the effluents of sulfate pulp factories, Lindvall (151) has measured olfactory intensity at the source and monitored the effects of various counter-measures. The report of an international symposium held in Stockholm in 1970 (249) provides an excellent handbook on methods for measuring and evaluating odorous air pollutants at the source and in the ambient air. Psychological research on aircraft and traffic noise has focused upon subjective annoyance, qualitative descriptions, and behavioral disruptions (92, 100, 136, 166). The predictability of noise and the individual's control over its termination appear to affect the degree of annoyance and behavioral disruption (211). Auditory studies of positive aspects of the sonic environment (238) include the qualitative evaluation of architectural acoustics in classrooms (194) and concert auditoria (110). Research on the quality of drinking water may be shifting from the use of expert panels to consumer assessments (39). Studies of the thermal properties of the environment typically deal with comfort ratings (124, 213), but Griffitt (101) reports a negative relationship between ambient effective room temperatures (i.e. 67.5 vs 90.6 degrees Fahrenheit) and interpersonal attraction. Multivariate analysis of weather conditions and police calls in Ft. Worth, Texas (227), suggests a tendency for police work to increase in warm, fair weather; however, physiological and psychological effects of temperature pressure have not yet been disentangled from seasonal activity patterns, amount of daylight, and similar variables. Appraising the quality of interior lighting is complicated by a positive sentiment for natural daylight (257). Thus far studies of windowless classrooms and offices do not point to any enlightening trends (215, 250). As a factor in person perception, the angle of light may influence such evaluative attributions as "threatening," "hostile," "friendly," and "determined" (22).

Ecological psychology and the analysis of behavior settings.—Since Barker's presentation of the state of ecological psychology in 1968 (19), expansions and empirical tests of the theory of behavior settings have been reported, and the technique of behavior setting surveys has been extended from small towns and schools to urban areas and an array of institutional settings. Several studies add further support for the hypothesis that the degree to which behavior settings are relatively under- or overmanned has significant consequences for setting occupants, at the levels of both overt behavior and subjective experiences (260, 262). For example, Wicker (261, 263) has shown that small churches tend to be undermanned, members of small churches display greater support and participation, and new members report greater assimilation than new members of larger churches. In an effort to move research on behavior settings beyond static description, Wicker (262) also examined several theoretical viewpoints on processes which may mediate behavior-environment congruence. Bechtel and his associates conducted behavior setting surveys of two poor urban neighborhoods and a public housing project (27–29), which were compared to a small town (i.e. Barker's Midwest). Bechtel (27) also reviewed the methodological problems entailed in extending this technique to large cities. Wright (277) summarized a series of comparative studies within the framework of ecological psychology dealing with children in small towns (less than 2000 persons) and a large town (32,858 persons). The technique of behavior setting surveys found continued application in studies of school environments and also in studies of treatment environments and residential contexts (103, 105, 146, 265). Gump (104) has addressed himself directly to the implications of ecological psychology for environmental design and planning, while Willems (266) related it to the wider range of research on man-environment relations and to the ecological movement. Particularly in its emphasis upon naturally occurring human behavior (20), it would be difficult to overestimate the pervasive influence of ecological psychology upon current research.

Human spatial behavior.—Significant recent publications include the papers of an international symposium on the use of space by animals and men (84), a collection of reports on the spatial behavior of older persons (190), and a book by Sommer on personal space (233). Studies of home range in human behavior have dealt with everyday out-of-the-house activities and extended travels (8, 49, 54, 133, 139). Some evidence points to the influence in children and adults of sex-role differences and access to modes of transportation (8, 50, 185, 189). For example, bike ownership appears to be positively related to home range among second and fourth graders (8). Social and personal factors influencing extent of home area and neighborhood schemes have been studied (42, 148). Altman (4) contributed an excellent conceptual analysis of territoriality, and Roos (214) introduced the concept of jurisdiction in an analysis of institutionally sanctioned temporary territories. Several reports have related dominance to territoriality, suggesting that highly dominant persons tend to move more freely among areas and use highly desirable areas (75, 83), but the findings of Sundstrom & Altman (245) point to a more complex relationship. Studies of men living in confinement (i.e. limited home range) indicate that incompatibility on personality traits increases territoriality and that temporal patterns of territoriality differ between dyads who complete the mission and those who abort (7). Although Hall (106) has suggested broad as well as narrow definitions, the term proxemics is increasingly used to refer at least to the study of interpersonal spatial behavior (56, 78, 255). The measurement of personal space has received methodological attention (31, 85, 208). Correlates of sex, race, status, and personality variables with interpersonal distance are being explored (23, 25, 122, 149, 168). Violations of personal space continue to be used in studying compensatory reactions to spatial intrusions (163, 192). Patterson & Sechrest (193) examined the effects of interpersonal distance on impression formation, finding ratings of social activity (i.e. friendliness, extraversion, dominance, aggressiveness) to decrease with distance. Lett, Clark & Altman (150) issued a useful propositional inventory of research on interpersonal distance. Altman & Lett (5) offered a broad ecological model of interpersonal relations, encompassing antecedent factors, stiuational definitions, environmental props, and the use of self-markers. In the same spirit, Mehrabian & Diamond (167) studied the effects of furniture arrangement, environmental props, interpersonal distance, and personality variables upon affiliative behavior and memory for the experimental room.

Behavioral effects of density.—Recent reviews (52, 278) document the striking paucity of scientific knowledge about the effects of density upon human behavior, but there is an abundance of speculation in the popular press and generalizations from animal research. However, experimental studies have finally begun to appear. In a series of experiments employing spatial densities as high as 4 square feet per person, Freedman, Klevansky & Ehrlich (89) found no evidence for any effect of density upon the performance of a range of simple and complex tasks. In a study employing a comparable range of spatial densities, Griffitt & Veitch (102) found density to be positively related to dysphoric mood ratings, negative evaluations of the experimental room and the experiment, and low interpersonal attraction. On the basis of studies with preschool children, McGrew (164) suggested that social density (i.e. the number of persons available for interaction) may have more important behavioral consequences than the spatial density of settings. Under conditions other than high spatial density, interpersonal distance (i.e. the physical distance between persons) can vary independently of social and spatial density. For example, Baxter & Deanovich (26) report that inappropriate crowding (i.e. experimenter's right shoulder less than 6 inches from subject's left shoulder) results in a higher degree of anxiety attributed to dolls in the Make-A-Picture-Story Test. Experimental studies will inevitably be limited in the durations and range of activities that can be analyzed. However, studies in natural settings (e.g. 223, 235) also present problems, particularly in disentangling extraneous correlates of density which may account for the observed behavioral outcomes. A somewhat distinct and noteworthy approach to the study of density has focused upon pedestrian behavior in notably crowded spaces such as lower Manhattan and the ticket halls of the London Underground (30, 242).

Behavioral factors in residential environments.—Except for a notable study by Fanning (87), research on housing and neighborhoods has shifted from experimental and quasi-experimental studies of behavioral impact to the analysis of attitudes, conceptions, and preferences and to the monitoring of behavior patterns that actually occur within them (74, 218). Altman, Nelson & Lett (6) and Perin (197) conducted detailed ecological studies of the daily patterns of behavioral use of home environments; Cooper (58) contributed an insightful analysis of the house as symbol of self; and Rapoport (207) and Canter & Thorne (46) surveyed sociocultural variations in house form and house preference. Patterns of residential preference, choice, and satisfaction have been related to a wide range of inhabitant characteristics (132, 140, 221). This research strategy has also been extended from the house itself to attributes of neighborhoods (141, 171, 198). The willingness to trade off house qualities in exchange for attractive natural surroundings (169), the perception of environmental threats in the residential setting (53), and judgments of residential livability under varying levels of street traffic (12) illustrate the new, broader approach. There is a promising trend toward research relating behavioral outcomes to behavioral assumptions and goals embedded in residential planning and design (42, 57, 59, 141, 173). The requirements of special user groups such as the elderly (48, 145), children (33, 206, 219), college students (93, 201, 258), and members of long-duration missions in space and undersea (186, 276) have received attention. Studies of the behavioral impact of migration and relocation continue to appear (137, 264, 276).

Behavioral factors in institutional environments.—Behavioral mappings of a wide variety of psychiatric wards (21, 105, 125, 126, 212, 239) represent considerable descriptive accomplishments, including the monitoring of behavioral patterns subsequent to design alterations on one ward (126) and the evolution of spatial behavior patterns in a new facility (273). These studies, and similar reports on rehabilitation treatment environments (146, 265), suggest an array of variables that may influence observed behavioral patterns, most notably, the interaction of administrative policies with physical attributes of settings. Fortunately, techniques for systematically assessing the physical properties, descriptive traits, and social atmospheres of treatment wards are becoming available for use in conjunction with behavioral mapping in multivariate research designs (178–181). Efforts to analyze these factors, plus patient and staff characteristics of ward users, face formidable problems and will entail large samples of treatment units. In other research on the hospital environment, the influence of nursing unit layouts upon nurses' travel, subjective states, and interaction with patients has been studied (153, 253), while factors influencing the distances patients travel to hospitals also received attention (182). In the school environment, comparisons of traditional and open plan schools (38, 77, 252) reveal differences in activity patterns, but whether they reflect the structure of daily programs (32) or innovative spatial arrangements is not yet clear, nor have the interdependencies among these factors been delineated. The effects of interior landscaping substituted for more typical barriers (e.g. walls) constitutes a somewhat analogous topic of research on office environments (37, 73, 256). Remarkably little empirical research has been reported on behavioral reactions to transit vehicles and facilities (66, 96, 131, 158, 177, 184), but current developments of rapid transit facilities may serve as an impetus to research in this area.

Outdoor recreation and response to landscape.—With few exceptions, research on the diverse forms of outdoor recreation has focused upon demographic and sociological variables; a psychological understanding of them remains quite a way down the trail. Characteristics of wilderness users have received some study and consideration in management policies (112, 170). With the remarkable increase in the popularity of hiking, camping, and similar activities, the environmental consequencies of user impacts are a source of concern, and efforts to control depreciative behaviors are under way (55, 111). Burgess, Clark & Hendee (40), evaluating six antilitter procedures, found the incentive technique most effective. In an ingenious study, Adams (3) related the decision to travel to a New England coastal beach to: (*a*) evaluation of the accuracy of weather information (e.g. on the prior evening newscast); (*b*) predicted and on-site weather conditions; and (*c*) factors affecting beach users' tolerance of suboptimal weather conditions (e.g. length of planning for the trip, group size). Appreciation of scenery is a component of many forms of outdoor recreation. A role theoretical analysis of the scenic observer has been advanced but remains untested (65). Research on descriptive and evaluative assessments of landscape may provide an empirical, behavioral basis for landscape aesthetics (61, 71, 72, 86, 205). Objective assessments of landscape quality are likely to find application in decision-making concerning preservation, forest management, and site-selection for outdoor recreational facilities (154,.200, 267, 279). The proceedings of two recent symposia provide a useful overview of research on outdoor recreation and response to landscape (135, 210).

Overview.—A broad, thin, but rapidly expanding layer of empirical research underlies current knowledge in environmental psychology. An intriguing question is whether environmental psychology will function narrowly and usefully as a chapter title for disparate but related topics, or will instead come to signify a coherent theoretical framework for understanding man-environment relations from a psychological perspective. Certainly there are conceptual resources at hand for encouraging aspirations to the latter goal, including the approach of ecological psychology (19), multivariate analysis of the interplay among personalitys, social and environmental systems (70, 225, 226), study of the dynamics of behavior-contingent physical systems (134, 244), and general models of behavioral adaptation and adjustment (127, 130, 270, 271, 272).

In light of the number of fronts currently under investigation along the behavior-environment interface, it is evident that the field could tolerate a significant increase in research manpower yet still retain its status as an undermanned behavior setting, with all its consequent benefits for individual participants (e.g. heightened responsibility and assimilation, diversity of activities, and experiences of obligation, involvement, and self-worth). Research in environmental psychology also offers investigators the attractions of multidisciplinary enterprise, cross-field efforts within psychology, and potential societal contributions in the form of more enlightened environmental decision-making.

LITERATURE CITED

1. Acker, M., McReynolds, P. 1967. The "need of novelty"; A comparison of six instruments. *Psychol. Rec.* 17:177–82
2. Acking, C., Kuller, R. 1971. Perception of the human environment. See Ref. 118, 46–53
3. Adams, R. L. A. 1971. *Weather, weather information, and outdoor recreation decisions: A case study of the New England beach trip.* PhD thesis. Clark Univ., Worcester, Mass.
4. Altman, I. 1970. Territorial behavior in humans: an analysis of the concept. See Ref. 190, 1–24
5. Altman, I., Lett, E. E. 1970. The ecology of interpersonal relationships: A classification system and conceptual model. In *Social and Psychological Factors in Stress*, ed. J. E. McGrath, 177–201. New York: Holt, Rinehart & Winston
6. Altman, I., Nelson, P. A., Lett, E. E. 1972. *The Ecology of Home Environments.* Salt Lake City: Univ. Utah. 201 pp.
7. Altman, I., Taylor, D. A., Wheeler, L. 1971. Ecological aspects of group behavior in social isolation. *J. Appl. Soc. Psychol.* 1:76–100
8. Anderson, J., Tindall, M. 1972. The concept of home range: New data for the study of territorial behavior. See Ref. 175, 1-1-1 to 1-1-7
9. Appleyard, D. 1969. City designers and the pluralistic city. In *Planning Urban Growth and Development*, ed. L. Rodwin, 422–52. Cambridge: MIT Press
10. Appleyard, D. 1969. Why buildings are known: A predictive tool for architects and planners. *Environ. Behav.* 1:131–56
11. Ibid 1970. Styles and methods of structuring a city. 2:100–18
12. Appleyard, D., Lintell, M. 1972. The environmental quality of city streets: The residents' viewpoint. *J. Am. Inst. Planners* 38:84–101
13. Archea, J., Eastman, C., Eds. 1970. *EDRA Two: Proc. 2nd Ann. Environ. Design Res. Assoc. Conf.* Pittsburgh: Carnegie-Mellon Univ.
14. Archea, J., Esser, A. H., Eds. 1969–present. *Man-Environment Systems.* University Park: Penn. State Univ.
15. Auliciems, A., Burton, I. 1970. Perception and awareness of air pollution in Toronto. *Univ. Toronto Dep. Geogr. Natural Hazard Res. Work. Pap. 13*
16. Bailey, R., Branch, C. H. H., Taylor, C. W., Eds. 1961. *Architectural Psychology and Psychiatry: An exploratory national research conference.* Salt Lake City: Univ. Utah
17. Baird, J. C., Degerman, R., Paris, R., Noma, E. 1972. Student planning of town configuration. *Environ. Behav.* 4:159–88
18. Barker, M. L., Burton, I. 1969. Differential response to stress in natural and social environments: An application of a modified Rosenzweig Picture-Frustration Test. *Univ. Toronto Dep. Geogr., Natural Hazard Res. Work. Pap. 5*
19. Barker, R. G. 1968. *Ecological Psychology: Concepts and Methods for Studying the Environment of Human Behavior.* Stanford Univ. Press. 242 pp.
20. Baker, R. G. 1968. Wanted: An ecobehavioral science. In *Naturalistic Viewpoints in Psychological Research*, ed. E. P. Willems, H. L. Raush, 31–43. New York: Holt, Rinehart & Winston
21. Barton, M., Mishkin, D., Spivack, M. 1971. Behavior patterns related to spatially differentiated areas of psychiatric ward dayroom. *Lab. Community Psychiatry, Harvard Med. Sch. Environ. Anal. Design Res. Rep. Ser. 5*
22. Barton, M., Spivack, M., Powell, P. The effect of angle of light on the recognition and evaluation of faces. *J. Illum. Eng. Soc. London.* In press
23. Batchelor, J. P., Goethals, G. R. Spatial arrangements in freely formed groups. *Sociometry.* In press
24. Baumann, D. D. 1969. The recreational use of domestic water supply reservoirs: Perception and choice. *Univ. Chicago Dep. Geogr. Res. Pap. 121*
25. Baxter, J. C. 1970. Interpersonal spacing in natural settings. *Sociometry* 33:444–56
26. Baxter, J. C., Deanovich, B. F. 1970. Anxiety arousing effects of inap-

propriate crowding. *J. Consult. Clin. Psychol.* 35:174–78

27. Bechtel, R. B. 1970. A behavioral comparison of urban and small town environment. See Ref. 13, 347–53
28. Bechtel, R. B. 1972. The public housing environment: A few surprises. See Ref. 175, 13-1-1 to 13-1-9
29. Bechtel, R. B., Achelpohl, C., Binding, F. R. S. 1971. East side, west side and midwest: A behavioral comparison of three environments. *Greater Kansas City Mental Health Found. Epidemiological Field Station Rep.*
30. Beck, R., Okamoto, R. Y. 1971. *Human Response to Patterns of Urban Density.* New York: Reg. Planning Assoc.
31. Becker, F. D., Mayo, C. 1971. Delineating personal distance and territoriality. *Environ. Behav.* 3:375–81
32. Berk, L. E. 1971. Effects of variations in the nursery school setting on environmental constraints and children's modes of adaptation. *Child Develop.* 42:839–69
33. Bishop, R. L., Peterson, G. L., Michaels, R. M. 1972. Measurement of children's preference for the play environment. See Ref. 175, 6-2-1 to 6-2-9
34. Blasdel, H. C. 1972. Multidimensional scaling for architectural environments. See Ref. 175, 25-1-1 to 25-1-12
35. Blaut, J. M., McCleary, G. F. Jr., Blaut, A. S. 1970. Environmental mapping in young children. *Environ. Behav.* 2:335–49
36. Borton, T. E., Warner, K. P. 1971. Involving citizens in water resources planning: The communication-participation experiment in the Susquehanna River Basin. *Environ. Behav.* 3:284–307
37. Brookes, M. J. 1972. Changes in employee attitudes and work practices in an office landscape. See Ref. 175, 14-1-1 to 14-1-9
38. Brunetti, F. A. 1972. Noise, distraction and privacy in conventional and open school environments. See Ref. 175, 12-2-1 to 12-2-6
39. Bruvold, W. H., Ongerth, H. J., Dillehay, R. C. 1969. Consumer assessment of mineral taste in domestic water. *J. Am. Water Works Assoc.* 61:575–80
40. Burgess, R. L., Clark, R. N., Hendee, J. C. 1971. An experimental analysis of anti-litter procedures. *J. Appl. Behav. Anal.* 4:71–75
41. Burton, I., Kates, R. W., Snead, R. E. 1969. The human ecology of coastal flood hazard in megalopolis. *Univ. Chicago Dep. Geogr. Res. Pap. 115*
42. Buttimer, A. 1972. Social space and the planning of residential areas. *Environ. Behav.* 4:267–78
43. Campbell, S. 1972. Architectural values as a measure of design decision-making: An empirical study using the conceptual framework of political science. See Ref. 175, 17-2-1 to 17-2-8
44. Canter, D. 1969. An intergroup comparison of connotative dimensions in architecture. *Environ. Behav.* 1:37–48
45. Canter, D., Ed. 1970. *Architectural Psychology. Proc. Conf. at Dalandhui, Univ. Strathclyde, 1969.* London: RIBA Publ. 92 pp.
46. Canter, D., Thorne, R. 1972. Attitudes to housing: A cross-cultural comparison. *Environ. Behav.* 4:3–32
47. Canter, D., Wools, R. 1970. A technique for the subjective appraisal of buildings. *Build. Sci.* 5:187–98
48. Carp, F. M. 1970. Correlates of mobility among retired persons. See Ref. 13, 171–82
49. Carp, F. M. Retirement travel. *Gerontologist.* In press
50. Carr, S., Herr, P., Cavellini, W., Dowds, P. 1972. *Status report on the Ecologue/Cambridgeport project.* Cambridge, Mass.: MIT Dep. Urban Studies and Planning
51. Carr, S., Schissler, D. 1969. The city as a trip: Perceptual selection and memory in the view from the road. *Environ. Behav.* 1:7–36
52. Carson, D. H. 1969. Population concentration and human stress. In *Explorations in the Psychology of Stress and Anxiety,* ed. B. P. Rourke, 24–42. Ontario: Longmans
53. Carson, D. H. 1972. Residential descriptions and urban threats. In *Environment and the Social Sciences: Perspectives and Applications,* ed. J. F. Wohlwill, D. H. Carson, 154–68. Washington, D.C.: Am. Psychol. Assoc.
54. Chapin, F. S. Jr., Logan, T. H. 1969. Patterns of time and space use. In *The Quality of Urban Environment: Essays on "New Resources" in an*

Urban Age, ed. H. S. Perloff, 305–32. Washington, D. C.: Resources for the Future

55. Clark, R. N., Hendee, J. C., Campbell, F. L. 1971. Depreciative behavior in forest campgrounds: An exploratory study. *USDA Forest Serv. Res. Note PNW-161*
56. Cook, M. 1970. Experiments on orientation and proxemics. *Hum. Relat.* 23:61–76
57. Cooper, C. 1971. St. Francis Square: Attitudes of its residents. *Am. Inst. Architects J.* 53:22–27
58. Cooper, C. 1971. The house as symbol of self. *Univ. California Berkeley Inst. Urban Reg. Develop. Work. Pap. 120*
59. Cooper, C., Hackett, P. 1968. Analysis of the design process at two moderate-income housing developments. *Univ. California Berkeley Cent. Planning Develop. Res. Work. Pap. 126*
60. Costantini, E., Hanf, K. 1972. Environmental concern and Lake Tahoe: A study of elite perceptions, backgrounds, and attitudes. *Environ. Behav.* 4:209–42
61. Coughlin, R. E., Goldstein, K. A. 1970. The extent of agreement among observers on environmental attractiveness. *Reg. Sci. Res. Inst. Discuss. Pap. Ser. 37*
62. Cox, K. R., Golledge, R. G., Eds. 1969. Behavioral problems in geography: A symposium. *Northwestern Univ. Stud. Geogr. 17*
63. Craik, K. H. 1966. The prospects for an environmental psychology. *IPAR Res. Bull.* Berkeley: Univ. California. 18 pp.
64. Craik, K. H. 1969. The architectural student in architectural society. *J. Am. Inst. Architects* 51:84–89
65. Craik, K. H. 1969. Human responsiveness to landscape: An environmental psychological perspective. *Sch. Design, N. C. State Univ., Stud. Publ.* 18:169–93
66. Craik, K. H. 1969. Transportation and the person. *High Speed Ground Transp. J.* 3:86–91
67. Craik, K. H. 1970. The environmental dispositions of environmental decision-makers. In *Society and Its Physical Environment*, ed. S. Klausner. *Ann. Am. Acad. Polit. Soc. Sci.* 389:87–94
68. Craik, K. H. 1970. Environmental psychology. In *New Directions in Psychology*, ed. K. H. Craik et al, 4:1–121. New York: Holt, Rinehart & Winston
69. Craik, K. H. 1971. The assessment of places. In *Advances in Psychological Assessment*, ed. P. McReynolds, 2:40–62. Palo Alto: Science and Behavior Books. 395 pp.
70. Craik, K. H. 1972. An ecological perspective on environmental decision-making. *Human Ecology* 1: 69–80
71. Craik, K. H. Appraising the objectivity of landscape dimensions. See Ref. 135
72. Craik, K. H. 1972. Psychological factors in landscape appraisal. *Environ. Behav.* 4:255–66
73. Davis, G. 1972. Using interviews of present office workers in planning new offices. See Ref. 175, 14-2-1 to 14-2-9
74. De Groot, I., Loring, W. C. 1968. Housing and health; A review of epidemiological assessments. *Proc. 5th Int. Congr. Hyg. Prev. Med.* 5:1–9
75. De Long, A. J. 1970. Dominance-territorial relations in a small group. *Environ. Behav.* 2:170–91
76. Dunlap, R., Gale, R. P. 1971. *Student recruitment into the environmental movement: A test of a reformulation of "mass society" theory.* Presented at Ann. Meet. Rural Sociol. Soc., Denver
77. Durlak, J. T., Beardsley, B. E., Murray, J. S. 1972. Observation of user activity patterns in open and traditional plan school environments. See Ref. 175, 12-4-1 to 12-4-8
78. Eastman, C. M., Harper, J. 1971. A study of proxemic behavior: Toward a predictive model. *Environ. Behav.* 3:418–38
79. Eberts, E. H. 1972. Social and personality correlates of personal space. See Ref. 175, 2-1-1 to 2-1-9
80. Edney, J. J. 1972. Place and space: The effects of experience with a physical locale. *J. Exp. Soc. Psychol.* 8:124–35
81. Engen, T. 1971. *Use of the sense of smell in determining environmental quality.* Presented at AAAS Symp.: Indicators of Environmental Quality, Philadelphia, Pa. 26 pp.
82. Erickson, D. L. 1971. Attitudes and communications about wildlife. *J. Environ. Educ.* 2:17–20
83. Esser, A. H. 1968. Dominance hierarchy and clinical course of psychiatrically hospitalized boys. *Child Develop.* 39:147–57
84. Esser, A. H., Ed. 1971. *Behavior and*

Environment: Use of Space by Animals and Men. New York: Plenum

85. Evans, G., Howard, R. B. 1972. A methodological investigation of personal space. See Ref. 175, 2-2-1 to 2-2-8
86. Fabos, J. 1971. An analysis of environmental quality ranking systems. In *Recreation Symp. Proc.* Upper Darby, Pa.: Northeast. Forest Exp. Sta. 211 pp.
87. Fanning, D. M. 1967. Families in flats. *Brit. Med. J.* 4:382–86
88. Frederiksen, M. 1972. Toward a taxonomy of situations. *Am. Psychol.* 27:114–23
89. Freedman, J. L., Klevansky, S., Ehrlich, P. R. 1971. The effect of crowding on human task performance. *J. Appl. Soc. Psychol.* 1:7–25
90. Friedman, S. M. 1969. *Relationship between cognitive complexity, interpersonal dimensions, and spatial preferences and propensities*. PhD thesis. Univ. California, Berkeley. 91 pp.
91. Gale, R. P. 1972. From sit-in to hike-in: A comparison of the civil rights and environmental movements. In *Social Behavior, Natural Resources, and the Environment*, ed. W. R. Burch Jr., N. H. Cheek Jr., L. Taylor, 280–305. New York: Harper and Row
92. Galloway, W. J., Clark, W. E., Kerrick, J. S. 1969. Highway noise; measurement, simulation, and mixed reactions. *Nat. Coop. Highway Res. Program Rep. 78*
93. Gerst, M. M., Moos, R. H. 1972. The psychological environment of university student residences. See Ref. 175, 13-3-1 to 13-3-9
94. Gittens, J. S. 1969. *Forming impressions of an unfamiliar city: A comparative study of aesthetic and scientific knowing*. MA thesis. Clark Univ., Worcester, Mass.
95. Golant, S. M., Burton, I. 1970. A semantic differential experiment in the interpretation and grouping of environmental hazards. *Geogr. Anal.* 2:120–34
96. Goldberg, T. 1969. The automobile: A social institution for adolescents. *Environ. Behav.* 1:157–86
97. Goldman, R., Platt, B., Kaplan, R. Dimensions of attitudes toward technology. *J. Appl. Psychol.* In press
98. Goodey, B. 1971. Perception of the environment. *Univ. Birmingham Cent. Urban Reg. Stud. Occas. Pap. 17*
99. Goodey, B., Duffett, A. W., Gold, J. R., Spencer, D. 1971. Cityscene: An exploration into the image of central Birmingham as seen by area residents. *Univ. Birmingham Cent. Urban Reg. Stud. Res. Memo. 10*
100. Griffiths, I. D., Langdon, F. J. 1968. Subjective response to road traffic noise. *J. Sound Vib.* 8:1–16
101. Griffitt, W. 1970. Environmental effects on interpersonal affective behavior: Ambient effective temperature and attraction. *J. Pers. Soc. Psychol.* 15:240–44
102. Griffitt, W., Veitch, R. 1971. Hot and crowded: Influences of population density and temperature on interpersonal affective behavior. *J. Pers. Soc. Psychol.* 17:92–98
103. Gump, P. V. 1969. Intra-setting analysis: The third grade classroom as a special but illustrative case. See Ref. 20, 200–20
104. Gump, P. V. 1971. Milieu, environment and behavior. *Design Environ.* 2:48–50
105. Gump, P. V., James, E. V. 1970. *Patient Behavior in Wards of Traditional and of Modern Design*. Topeka: Environ. Res. Found. 115 pp.
106. Hall, E. T. 1968. Proxemics. *Curr. Anthropol.* 9:83–108
107. Hall, W. B., MacKinnon, D. W. 1969. Personality inventory correlates of creativity among architects. *J. Appl. Psychol.* 53:322–26
108. Harry, J., Gale, R., Hendee, J. 1969. Conservation: An upper-middle class social movement. *J. Leisure Res.* 1:246–54
109. Hart, R. A., Moore, G. T. The development of spatial cognition: a review. In *Images of Man's Spatial Environment*, ed. D. Stea, R. Downs. Chicago: Aldine-Atherton. In press
110. Hawkes, R. J., Douglas, H. 1971. Subjective acoustic experience in concern auditoria. *Acustica* 24: 235–50
111. Heberlein, T. A. 1971. *Moral norms, threatened sanctions, and littering behavior*. PhD thesis. Univ. Wisconsin, Madison
112. Hendee, J. C., Catton, W. R. Jr., Marlow, L. D., Brockman, C. G. 1968. Wilderness users in the

Pacific Northwest—their characteristics, values, and management preferences. *USDA Forest Ser. Res. Pap. PNW-61*

113. Hendee, J. C., Harris, R. W. 1970. Foresters' perception of wilderness-user attitudes and preferences. *J. Forestry* 68:759–62
114. Hershberger, R. G. 1969. *A study of meaning and architecture.* PhD thesis. Univ. Pennsylvania, Philadelphia
115. Hershberger, R. G. 1972. Toward a set of semantic scales to measure the meaning of architectural environments. See Ref. 175, 6-4-1 to 6-4-10
116. Hesselgren, S. 1971. *Experimental Studies on Architectural Perception.* Stockholm: Nat. Swed. Inst. Build. Res. 104 pp.
117. Hill, W., White, R. C. 1969. New horizons for environmental education. *J. Environ. Educ.* 1:43–46
118. Honikman, B., Ed. 1971. *AP 70: Proc. Architect. Psychol. Conf. at Kingston Polytechnic 1970.* London: RIBA Publ. 98 pp.
119. Honikman, B. 1972. An investigation of the relationship between construing of the environment and its physical form. See Ref. 175, 6-5-1 to 6-5-11
120. Honikman, B., Bridge, A., Lee, S., Eds. 1969–present. *Architectural Psychology Newsletter.* Surrey, Engl.: Kingston Polytechnic
121. Horowitz, H. 1966. The architect's programme and the behavioural sciences. *Architect. Sci. Rev.* 9:71–79
122. Horowitz, M. J. 1968. Spatial behavior and psychopathology. *J. Nerv. Ment. Dis.* 146:24–35
123. Howard, R. B., Mlynarski, F. G., Sauer, G. C. Jr. 1972. A comparative analysis of affective responses to real and represented environments. See Ref. 175, 6-6-1 to 6-6-8
124. Humphreys, M. A., Nicol, J. F. 1970. An investigation into thermal comfort of office workers. *J. Inst. Heat Vent. Eng.* 38:181–89
125. Ittelson, W. H., Proshansky, H. M., Rivlin, L. G. 1970. Bedroom size and social interaction of the psychiatric ward. *Environ. Behav.* 2: 255–70
126. Ittelson, W. H., Proshansky, H. M., Rivlin, L. G. 1970. The environmental psychology of the psychiatric ward. See Ref. 202, 419–38
127. Kaplan, S. 1972. The challenge of environmental psychology: A proposal for a new functionalism. *Am. Psychol.* 27:140–43
128. Kaplan, S., Wendt, J. S. 1972. Preference and the visual environment: Complexity and some alternatives. See Ref. 175, 6-8-1 to 6-8-5
129. Kasmar, J. V. 1970. The development of a usable lexicon of environmental descriptors. *Environ. Behav.* 2:153–69
130. Kates, R. W. 1971. Natural hazard in human ecological perspective: Hypotheses and models. *Econ. Geogr.* 47:438–51
131. Ketola, H. N. et al 1970. *Bus Design: Concepts and Evaluation.* Troy, N. Y.: Rensselaer Res. Corp. 211 pp.
132. Knight, R. L. 1971. *Mobile home and conventional home owners: a comparative examination of socioeconomic characteristics and housing-related preferences of young families in Chicago.* PhD thesis. Northwestern Univ., Evanston, Ill. 236 pp.
133. Kranz, P. 1970. What do people do all day? *Behav. Sci.* 15:286–91
134. Krasner, L. 1971. Behavior therapy. *Ann. Rev. Psychol.* 22:483–532
135. Krutilla, J., Ed. *Natural Environments: Studies in Theoretical and Applied Analysis.* Baltimore: Johns Hopkins Univ. Press. In press
136. Kryter, K. D. 1970. *The Effects of Noise on Man.* New York: Academic
137. Kuhl, P. H., Koch-Nielsen, I. 1971. Slum clearance areas in Copenhagen. *Danish Nat. Inst. Soc. Res. Publ. 51*
138. Ladd, F. C. 1970. Black youths view their environment: Neighborhood maps. *Environ. Behav.* 2:74–99
139. Ladd, F. C. 1970. *Travels and travels in fantasy of black youths.* Presented at N. Engl. Psychol. Assoc. Meet., Boston
140. Ladd, F. C. Black youths view their environments: Some views of housing. *J. Am. Inst. Planners* 38: 108–15
141. Lansing, J. B., Marans, R. W. 1969. Evaluation of neighborhood quality. *J. Am. Inst. Planners* 35:195–99
142. Lau, J. 1970. Differences between full-size and scale-model rooms in the assessment of lighting quality. See Ref. 45, 43–48
143. Laumann, E. O., House, J. S. 1970.

Living room styles and social attributes: The patterning of material artifacts in a modern urban community. *Sociol. Soc. Res.* 54: 321–42

144. Laurendeau, M., Pinard, A. 1971. *The Development of the concept of space in the Child.* New York: Int. Univ. Press

145. Lawton, M. P. 1970. Public behavior of older people in congregate housing. See Ref. 13, 372–80

146. LeCompte, W. F., Willems, E. P. Ecological analysis of a hospital: Location dependencies in the behavior of staff and patients. See Ref. 13, 236–45

147. Lee, T. 1968. Urban neighborhood as a socio-spatial schema. *Hum. Relat.* 21:241–68

148. Lee, T. R. 1970. Perceived distance as a function of direction in the city. *Environ. Behav.* 2:40–51

149. Leibman, M. 1970. The effects of sex and race norms on personal space. *Environ. Behav.* 2:208–46

150. Lett, E. E., Clark, W., Altman, I. 1969. A propositional inventory of research on interpersonal distance. *Naval Med. Res. Inst. Res. Rep. 1*

151. Lindvall, T. 1970. On sensory evaluation of odorous air pollutant intensities. *Nord. Hyg. Tidskr.*, Suppl. 2

152. Lipman, A. 1969. The architectural belief system and social behaviour. *Brit. J. Sociol.* 20:190–204

153. Lippert, S. 1971. Travel in nursing units. *Hum. Factors* 13:269–82

154. Litton, R. B. Jr. Aesthetic dimensions of the landscape. See Ref. 135

155. Lowenthal, D. 1968. Environmental perception project. *Man Environ.* 1:3–6

156. Lowenthal, D. 1970. *The nature of perceived and imagined environments.* Presented at N. Engl. Psychol. Assoc. Meet. Boston

157. Lynch, K. 1960. *The Image of the City.* Cambridge: MIT Press

158. Marek, J., Sten, T. 1971. *Driver behavior and traffic environment: A critical examination and a point of view.* Trondheim, Norway: Norw. Inst. Technol., Univ. Trondheim

159. Mark, L. S. 1972. Modeling through toy play: A methodology for eliciting topographical representations in children. See Ref. 175, 1-3-1 to 1-3-9

160. Marshall, N. 1970. Environmental components of orientations toward privacy. See Ref. 13, 246–51

161. Ibid. Personality correlates of orientations toward privacy, 316–19

162. McCarroll, J. E., Mitchell, K. M., Carpenter, R. J., Anderson, J. P. 1967. Analysis of three stimulation-seeking scales. *Psychol. Rep.* 21: 853–56

163. McDowell, K. V. 1972. Violations of personal space. *Can. J. Behav. Sci.* 4:210–17

164. McGrew, W. C. 1972. Interpersonal spacing of preschool children. In *The Development of Competence in Early Childhood*, ed. J. S. Bruner, K. J. Connolly. London: Academic

165. McKechnie, G. E. 1970. Measuring environmental dispositions with the Environmental Response Inventory. See Ref. 13, 320–26

166. McKennel, A. C. 1969. Methodological problems in a survey of aircraft noise annoyance. *Statistician* 19:1–29

167. Mehrabian, A., Diamond, S. G. 1971. Effects of furniture arrangement, props, and personality on social interaction. *J. Pers. Soc. Psychol.* 20:18–30

168. Mehrabian, A., Diamond, S. G. 1971. Seating arrangement and conversation. *Sociometry* 34:281–89

169. Menchik, M. D. 1971. Residential environmental preferences and choice: Some preliminary empirical results relevant to urban form. *Reg. Sci. Res. Inst. Discuss. Pap. Ser. 46*

170. Merriam, L. C. Jr., Ammons, R. B. 1968. Wilderness users and management in three Montana areas. *J. Forestry* 66:390–95

171. Michelson, W. H. 1970. *Man and his Urban Environment: A Sociological Approach.* Reading, Mass.: Addison-Wesley

172. Milgram, S. 1970. The experience of living in cities. *Science* 167: 1461–68

173. Miller, A., Cook, J. A. 1967. Radburn Estates revisited: Report of a user study. *Architects J.* 146: 1075–82

174. Mitchell, B. 1971. Behavioral aspects of water management: A paradigm and a case study. *Environ. Behav.* 3:135–54

175. Mitchell, W. J., Ed. 1972. *Environmental design: Research and practice. Proc. EDRA Three/AR 8*

Conf. Jan. 1972. Los Angeles: Univ. California Press

176. Moore, G. T. 1970. *Emerging Methods in Environmental Design and Planning.* Cambridge: MIT Press
177. Moorhead, R., Lepper, R. 1970. Transit vehicle design and rider satisfaction. *Urban Soc. Change Rev.* 4:6–10
178. Moos, R. H. 1971. *Revision of the ward atmosphere scales (WAS): Technical report.* Soc. Ecol. Lab., Stanford Univ.
179. Ibid 1972. *British psychiatric ward treatment environments*
180. Moos, R. H., Harris, R., Schonborn, K. 1969. Psychiatric patients and staff reaction to their physical environments. *J. Clin. Psychol.* 25: 322–24
181. Moos, R. H., Houts, P. S. 1970. Differential effects of the social atmospheres of psychiatric wards. *Hum. Relat.* 23:47–60
182. Morrill, R. L., Earickson, R. J., Rees, P. 1970. Factors influencing distances traveled to hospitals. *Econ. Geogr.* 46:161–71
183. Morrison, D. E., Hornback, K. E., Werner, W. K. 1972. The environmental movement: Some preliminary observations and predictions. See Ref. 91
184. Murray, J. J., Ed. *Urban and Regional Surveys and Readings in Ground Transportation.* New York: Wiley. In press
185. Nahemow, L., Kogan, L. S. 1971. *Reduced Fare for the Elderly.* New York: Environ. Psychol. Program, City Univ. New York
186. Nowlis, D. P., Wortz, E. C., Watters, H. 1972. *Tektite II: Habitability research program.* Marshall Space Flight Center, Ala.: NASA
187. O'Riordan, T. 1971. Public opinion and environmental quality: A reappraisal. *Environ. Behav.* 3:191–214
188. Orleans, P. A. Differential cognition of urban residents: Effects of social scale on mapping. See Ref. 109
189. Orleans, P. A., Schmidt, S. 1972. Mapping the city: Environmental cognition of urban residents. See Ref. 175, 1-4- to 1-4-9
190. Pastalan, L., Carson, D. H., Eds. 1970. *Spatial Behavior of Older People.* Ann Arbor: Univ. Michigan-Wayne State Univ. Press
191. Patterson, G. R., Bechtel, G. G. 1971. Formulating the situational environment in relation to states and traits. Ore. Res. Inst. Bull. 11:1–40
192. Patterson, M. L., Mullens, S., Romano, J. 1971. Compensatory reactions to spatial intrusion. *Sociometry* 34:114–21
193. Patterson, M. L., Sechrest, L. B. 1970. Interpersonal distance and impression formation. *J. Pers.* 38: 161–66
194. Payne, I. 1972. New methods and research in qualitative evaluation of architectural acoustics. See Ref. 175, 25-3-1 to 25-3-18
195. Payne, I. Multidimensional scaling in environmental research. *Architectural Science Review.* In press
196. Pearson, P. H. 1970. Relationships tween global and specified measures of novelty seeking. *J. Consult. Clin. Psychol.* 34:199–204
197. Perin, C. 1972. Concepts and methods for studying environments in use. See Ref. 175, 13-6-1 to 13-6-10
198, Peterson, G. L. 1967. Measuring visual preferences of residential neighborhoods. *Ekistics* 23:169–73
199. Peterson, G. L. 1971. *Motivations, perceptions, satisfactions, and environmental dispositions of Boundary Waters Canoe Area users and managers.* Northwestern Univ. Technol. Inst.
200. Peterson, G. L., Neumann, E. S. 1969. Modeling and predicting human response to the visual recreation environment. *J. Leisure Res.* 1:219–37
201. Preiser, W. F. E. 1970. Behavioral design criteria in student housing. See Ref. 220, 243–69
202. Proshansky, H. M., Ittelson, W. H., Rivlin, L. G., Eds. 1970. *Environmental Psychology: Man and his Physical Setting.* New York: Holt, Rinehart & Winston. 690 pp.
203. Pyron, B. 1971. Form and space diversity in human habitats: Perceptual responses. *Environ. Behav.* 3:382–411
204. Ibid 1972. Form and diversity in human habitats: judgmental and attitude responses. 4:87–120
205. Rabinowitz, C. G., Coughlin, R. E. 1971. *Some experiments in quantitative measurement of landscape quality.* Philadelphia: Reg. Sci. Res. Inst.
206. Rand, G. 1972. Children's images of houses: A prolegomena to the study of why people still want

pitched roofs. See Ref. 175, 6-9-1 to 6-9-10

207. Rapoport, A. 1969. *House Form and Culture.* New York: Prentice-Hall
208. Rawls, J. R., Trego, R. E., McGaffrey, C. H. 1968. A comparison of personal space measures. *Texas Christian Univ. Inst. Behav. Res. Tech. Rep. 6*
209. Ibid 1968. Correlates of personal space. *Tech. Rep. 7*
210. *Recreation Symp. Proc.* 1971. Upper Darby, Pa.: Northeast. Forest Exp. Sta.
211. Reim, B., Glass, D. C., Singer, J. E. 1972. Behavioral consequences of exposure to uncontrollable and unpredictable noise. *J. Appl. Soc. Psychol.* 1:44–56
212. Rivlin, L. G., Wolfe, M. 1972. The early history of a psychiatric hospital for children: Expectations and reality. *Environ. Behav.* 4: 33–72
213. Rohles, F. H. Jr. 1970. The modal comfort envelope: A new approach toward defining the thermal environment in which sedentary man is comfortable. *ASHRAE Trans.* 76:308–17
214. Roos, P. D. 1968. Jurisdiction: an ecological concept. *Hum. Relat.* 21:75–84
215. Ruys, T. 1970. *Windowless offices.* MA thesis. Univ. Washington, Seattle. 63 pp.
216. Saarinen, T. F. 1969. Perception of environment. *Comm. Coll. Geogr. Resource Pap. 5*
217. Saarinen, T. F., Cooke, R. U. 1971. Public perception of environmental quality in Tucson, Arizona. *J. Ariz. Acad. Sci.* 6:260–74
218. Sanoff, H. 1971. The social implications of residential environments. *Int. J. Environ. Stud.* 2:13–19
219. Sanoff, H., Coates, G. 1970. Behavioral mapping: An ecological analysis of activities in a residential setting. *Int. J. Environ. Stud.* 1:1–9
220. Sanoff, H., Cohn, S., Eds. 1970. *EDRA One: Proc. 1st Ann. Environ. Design Res. Assoc. Conf.* Raleigh: North Carolina State Univ.
221. Sanoff, H., Sawhney, M. 1972. Residential livability: A study of user attitudes towards their residential environment. See Ref. 175, 13-8-1 to 13-8-10
222. Schiff, M. 1971. *Psychological factors related to human adjustment to natural hazards in London, Ontario.* Presented at Assoc. Am. Geogr. Meet., Boston
223. Schmitt, R. C. 1963. Implications of density in Hong Kong. *J. Am. Inst. Planners* 29:21–26
224. Seaton, R. W., Collins, J. B. 1972. Validity and reliability of ratings of simulated buildings. See Ref. 175, 6-10-1 to 6-10-12
225. Sells, S. B. 1969. Ecology and the science of psychology. See Ref. 20, 15–30
226. Sells, S. B. 1971. *Environmental assessment: A context for the study of human behavior.* Presented at APA Meet., Washington, D. C.
227. Sells, S. B., Will, D. P. Jr. 1971. *Accidents, police incidents and weather: A further study of the city of Fort Worth, Texas, 1968.* Fort Worth: Inst. Behav. Res., Texas Christian Univ.
228. Sewell, W. R. D. 1971. Environmental perceptions and attitudes of engineers and public health officials. *Environ. Behav.* 3:23–59
229. Sewell, W. R. D., Foster, H. D. 1971. Environmental revival: Promise and performance. *Environ. Behav.* 3:123–34
230. Shafer, E. L. Jr., Thompson, R. C. 1968. Models that describe use of Adirondack campgrounds. *Forest Sci.* 14:383–91
231. Sims, J., Baumann, D. D. 1971. *The tornado threat: Coping styles of the North and South.* Presented at Ann. Meet. Assoc. Am. Geogr., Boston
232. Sims, J., Saarinen, T. F. 1969. Coping with environmental threat: Great Plains farmers and the sudden storm. *Ann. Assoc. Am. Geogr.* 59: 677–86
233. Sommer, R. 1969. *Personal Space: The Behavioral Basis of Design.* Englewood Cliffs, N. J.: Prentice-Hall
234. Sommer, R. 1972. *Design Awareness.* San Francisco: Rinehart
235. Sommer, R., Becker, F. D. 1971. Room density and user satisfaction. *Environ. Behav.* 3:412–17
236. Sonnenfeld, J. 1969. Equivalence and distortion of the perceptual environment. *Environ. Behav.* 1: 83–100
237. Sonnenfeld, J. 1969. Personality and behavior in environment. *Proc. Assoc. Am. Geogr.* 1:136–40
238. Southworth, M. 1969. The sonic en-

vironment of cities. *Environ. Behav.* 1:49–70

239. Srivastava, R. K., Good, L. R. 1968. Human movement as a function of color stimulation. *Environ. Res. Found. Rep.*
240. Stea, D. 1969. On the measurement of mental maps: An experimental model for studying conceptual spaces. *Northwestern Univ. Stud. Geogr. 17*
241. Stern, G. G. 1970. *People in Context: The Measurement of Environmental Interaction in School and Society.* New York: Wiley
242. Stilitz, I. B. 1969. The role of static pedestrian groups in crowded spaces. *Ergonomics* 12:821–39
243. Stringer, P. 1971. Spatial ability in relation to design problem solving. See Ref. 118, 21–23
244. Studer, R. G. 1970. The dynamics of behavior-contingent physical systems. See Ref. 202, 56–75
245. Sundstrom, E., Altman, I. 1972. *Relationships between dominance and territorial behavior: A field study in a youth rehabilitation setting.* Salt Lake City: Univ. Utah
246. Swan, J. 1970. Response to air pollution: A study of attitudes and coping strategies of high school youths. *Environ. Behav.* 2: 127–53
247. Taylor, C. W., Bailey, R., Branch, C. H. H., Eds. 1967. *Nat. Conf. Architect. Psychol., 2nd.* Salt Lake City: Univ. Utah
248. Thiel, P. 1970. Notes on the description, scaling, notation, and scoring of some perceptual and cognitive attributes of the physical environment. See Ref. 202, 593–618
249. Third Karolinska Inst. Symp. Environ. Health 1970. Methods for measuring and evaluating odorous air pollutants at the source and in the ambient air. *Nord. Hyg. Tidskr.* 51:1–77
250. Tikkanen, K. T. 1970. *Significance of windows in classrooms.* MA thesis. Univ. Calif., Berkeley. 58 pp.
251. Tognacci, L. N., Weigel, R. H., Wideen, M. F., Vernon, D. T. A. 1972. Environmental quality: How universal is public concern? *Environ. Behav.* 4:73–86
252. Trieschmann, G. V. 1970. *Open plan schools, a comparative study.* PhD thesis. Univ. Utah, Salt Lake City 182 pp.
253. Trites, D. K., Galbraith, F. D. Jr., Sturdavant, M., Leckwart, J. F. 1970. Influence of nursing—unit design on the activities and subjective feelings of nursing personnel. *Environ. Behav.* 2:303–34
254. Vayda, A. P., Ed. 1972–present. *Human Ecology.* New York: Plenum
255. Watson, O. M. 1972. *Symbolic and Expressive Uses of Space: An Introduction to Proxemic Behavior.* Reading, Mass.: Addison-Wesley
256. Wells, B. W. P. 1965. The psychosocial influence of building environment: Sociometric findings in large and small office spaces. *Build. Sci.* 1:153–65
257. Ibid. Subjective responses to the lighting installation in a modern office building and their design implications, 57–68
258. Wheeler, L. 1972. Student reactions to campus planning options: A regional comparison. See Ref. 175, 12-8-1 to 12-8-9
259. White, G. F. 1971. The role of public opinion. In *Environmental Quality and Water Development.* Nat. Water Comm., Washington, D. C.
260. Wicker, A. W. 1968. Undermanning, performances, and students' subjective experiences in behavior settings of large and small high schools. *J. Pers. Soc. Psychol.* 10: 255–61
261. Ibid 1969. Size of church membership and members' support of church behavior settings. 13: 278–88
262. Wicker, A. W. 1972. Processes which mediate behavior-environment congruence. *Behav. Sci.* 17:265–77
263. Wicker, A. W., Mehler, A. 1971. Assimilation of new members in a large and a small church. *J. Appl. Psychol.* 55:151–56
264. Wilkie, R. W. 1971. Toward a behavioral model of peasant migration: An Argentine case of spatial behavior by social class level. Washington, D. C.: Panam. Inst. Geogr. Hist.
265. Willems, E. P. 1972. Place and motivation: Independence and complexity in patient behavior. See Ref. 175, 4-3-1 to 4-3-8
266. Willems, E. P. Behavioral ecology and experimental analysis: Courtship is not enough. In *Methodological Issues in Life-Span Developmental Psychology,* ed. H.

Reese, T. Nesselroade. New York: Academic. In press

267. Wilson, S. O., Beavers, D. J., Fullen, B., Pierson, N. 1970. Potential recreation and open space areas in New York State. *Tech. Pap. 6, NY State Off. Parks & Recreation*
268. Winkel, G. H., Ed. 1969–present. *Environment and Behavior*. Beverly Hills, Calif.: Sage
269. Winkel, G. H., Malek, R., Thiel, P. 1969. The role of personality differences in judgments of roadside quality. *Environ. Behav.* 1:199–224
270. Wohlwill, J. F. 1970. The emerging discipline of environmental psychology. *Am. Psychol.* 25:303–12
271. Wohlwill, J. F. Behavioral response and adaptation to environmental stimulation. In *Physiological Anthropology*, ed. A. Damon. Cambridge: Harvard Univ. Press. In press
272. Wohlwill, J. F., Kohn, I. 1971. *Migrants' response to their new environment: An adaptation-level Approach*. Presented at AAAS Symp. Human Response to Environ. Stimulation, Philadelphia
273. Wolfe, M., Rivlin, L. 1972. Evolution of space utilization patterns in a children's psychiatric hospital. See Ref. 175, 5-2-1 to 5-2-10
274. Wood, W. 1971. Simulation: A comparison of color film, black & white film, and video tape to reality in the simulation of architectural models. Vancouver: Univ. British Columbia
275. Wools, R., Canter, D. 1970. The effect of the meaning of buildings on behavior. *Appl. Ergonomics* 1: 144–50
276. Wortis, E. C., Ed. 1970. *1st Nat. Symp. Habitability*. Los Angeles: Airsearch Mfg. Co. 4 vols.
277. Wright, H. F. 1970. *Children in smalltown and largetown USA: A summary of studies in the ecological psychology of community size*. Lawrence: Univ. Kansas
278. Zlutnick, S., Altman, I. 1972. Crowding and human behavior. See Ref. 53, 44–60
279. Zube, E. H. 1970. Evaluating the visual and cultural landscape. *J. Soil Water Conserv.* 25:137–41
280. Zuckerman, M. 1971. Dimensions of sensation seeking. *J. Consult. Clin. Psychol.* 36:45–52

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SOCIAL AND COMMUNITY INTERVENTIONS[1] 208

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INTRODUCTION: SCOPE OF THE FIELD

Not infrequently, chapters in the *Annual Review of Psychology* begin with some variant of a simple framing stem such as: "During the past 12 months . . . " etc. This order of housing does not well fit a debut chapter on the titillating, but still misty, topic of Social and Community Interventions. There is every reason to suppose that this concept, however attractive and zeitgeisty as an abstraction, is fully as amorphous as other kindred, currently popular ones such as community mental health (CMH), community psychology, community psychiatry, social psychiatry (76, 106, 134, 365). While such abstractions are for many haloed as God, motherhood, and flag, the actual functions they subsume may range from showing Szondi plates to ghetto residents in an inner-city store front to engineering new communities.

Thus, simply to preen one's scholarly feathers and to plunge unswervingly into a full-dressed review of a fixed domain, proclaimed by fiat as *the* turf, would be arbitrary and unrealistic. There is much greater need to understand the problems that have energized the social and community (SC) thrust, and to arrive at a preliminary set of interrelated concepts which collectively offer an attractive alternative to past dominant efforts to cope with such problems. Without debating the question of whether social and community interventions (SCI) is genuinely a new area for psychology, a view rendered doubtful by several recent, scholarly, historical analyses (56, 228, 229), versus merely several ancient ones gerrymandered, the fact that it surfaces at this time dictates that more than usual attention be directed to "gut" articulating questions such as: "What is the field all about?" "Why does it emerge now?" "What are its main challenges and opportunities?"

One genuine appeal to the writer of a "first" chapter is that he is less encumbered by constraints and fixities that are inherent in more codified fields. In the absence of clear "no-nos" he has more than the usual opportunity to disport cherished notions and hard come-by prejudices. Unfortunately, this advantage is also a disadvantage in that readers (who, if all goes well, may outnumber the author) have precisely the same rights and privileges. To the extent that fellow blind men see different parts of a projective elephant, the writer is fully vulnerable to the "why-that-and-not-this?" reaction syndrome.

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[1] The following abbreviations are used in this chapter: C (control); CMH (community mental health); E (experimental); IDS (Institute for Developmental Studies); IYS (Institute for Youth Studies); MH (mental health); NSC (Neighborhood Service Center); RYC (Residential Youth Center); SC (social-community); SCI (social-community interventions).

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It may be instructive to consider this chapter in the context of a brief review of the history of the *Annual Review of Psychology*—itself a "social institution" that has had significant input into shaping the discipline over the past quarter century. For 23 years a chapter on Psychotherapy has always been a surety[3] of the *Review*. Investment in this generic area was strongest during the *Review*'s initial decade when each volume included separate chapters on Counseling and Psychotherapy. Whether that mini-moment in history happened as it did by plan or default, it betrays several highly influential, buried assumptions that bear excavation, dusting off, and critical re-examination in the context of today's rapidly shifting social forces. These assumptions have to do with the mental health (MH) professions' views about how best to approach and deal with complex problems of disordered behavior. Clinical theorizing, derivative practice, and research all mirror the implicit assumption that the time to initiate help is when a person experiencing problems, sometimes grave, recognizes them and/or is rendered ineffectual by them. At such moments, he, or those responsible for him, send out a cry for help. We have thus been markedly shaped by an "end-state" mentality wherein interventions begin when rooted dysfunctions (e.g. neuroses, addictions, schizophrenias) exceed threshold, disrupt the individual's happiness or effectiveness, or intrude on others. The core aim of ensuing interventions has been to relieve the debilitating conditions, i.e. to rehabilitate an already disabled—sometimes chronically so—individual!

Modally, clinical interventions have taken place in one-to-one formats and have been partial to the view that some variant of the generic giant of psychotherapy is the structural approach of choice in our helping armamentarium. The foregoing assumptions and ways of proceeding are hardly exclusive to clinical psychology; rather, they have long governed the approaches of all helping professions. Implicitly, though perhaps unintentionally, they have been dignified and strengthened by the *Review*'s decision to include a chapter on Psychotherapy in all prior volumes. It is as if we have automatically accepted the identity: "Helping people in distress = Psychotherapy"! If indeed we have succumbed to this view, a confluence of the past decade's swelling tides necessarily raises two critical issues: Should the primary efforts of the helping professions be directed to individuals in current psychic distress and, if so, how much of the investment should, specifically, be in psychotherapy?

Ferment generated by these issues prompted the *Review* to formulate a new policy about future chapter organization and content in this area. Thus, the preface to Volume 22 advances a long-range plan to rotate triannually chapters dealing with approaches to Intervention in Psychopathology—individual, group and social-community—and to include an additional chapter each fourth year on Prevention of Mental Disorders.

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[3] Except for Volume 20 where the chapter, though "commissioned," was not completed.

The reviewer, from his position of infinite bias, applauds the wisdom of this "game-plan" but questions its specifics, particularly as they pertain to the actual meaning of the four concepts comprising the new, holy quadroika. Whereas individual and group interventions have established histories in a repair tradition, prevention, in principle, does exactly the opposite, i.e. it short-circuits the need for repair. The trickiest of the four concepts, unfortunately, is SCI, which at the moment is little more than a polymorphous perverse locus-designator. As this concept clarifies, the new *Review* chapter organization proposed in Volume 22 may come to grief. (Indeed, the writer will do his best to *cause* this to happen!) Ultimately the most important conceptual distinction should be the one between rehabilitative-restorative efforts and preventive-prophylactic ones. The importance of "community" lies in the opportunities it affords for reconceptualizing and for preventive programming. Thus, future chapters on individual and probably on group interventions are likely to favor the established psychotherapy mold, while SC and prevention chapters may fuse.

Neither pedantry nor the sheer joy of semantics prompt the above distinction. Rather it is needed to set a tone for this chapter! The author's interest in a social and community framework lies in its potential for generating bonafide, particularly preventive, alternatives to traditional MH programming. He is reluctant to accept the views that we can only, or best, help people when they are distressed, or that MH work should begin only after pathology appears. The latter may be too strongly implied by the *Annual Review*'s new chapter organization plan, when SCI is listed as a subhead under Interventions in *Psychopathology*.

What *is* a proper scope for SCI? For a fleeting, hopeful moment, the writer thought that he might answer this question via a lazy man's promenade in operationism. His reasoning, more defensible logically than empirically, was that the *Community Mental Health Journal* (CMHJ), regarded by many as a front-and-center exemplar of this new domain, had been in existence for about 7 years, exactly the period of marked swelling of the SC tides. Should not a careful content analysis of the articles appearing in this journal provide the Talmudic wisdom—the blinding glimpse of the obvious—about the area's precise nature? Retrospect indicates that the foregoing assumption was, charitably speaking, an exercise in pious naivete.

In the 7-year period between the first CMHJ issue and June 1971, 31 numbers appeared, containing about 330 papers. The chronicler would be able whose conceptual powers allowed him to "shoe-horn" these 330 papers into as few as 100 categories. By federating families of topics (e.g. mental illness, the mentally ill, mental hospitals, mental patients) one can eke out some 30–35 papers. Other gelatinous rubrics such as "programs and descriptions" and "planning" account for perhaps another score. Special topics that have attracted "one-shot" attention are numerous—e.g. articles about judges, unwed mothers, the dying, parents of preemies, and MH among the Eskimos—each has its assigned space. The full spectrum of content baffles and defies most sophisticated machine factor analysis and the most perspicacious eyeball. Moreover, the ratio of speculation to research is alarmingly high. If one uses the liberal criterion of whether the author mentions a number or draws a chart to classify a contribution as "research," about 3 of 10 CMHJ articles is "researchy." Of those, a fair number are simply descriptive (e.g. 30% of the dischargees from hospital X were ages 40-50, and 20% were ages 50-60).

Although this brave venture in cataloguing failed abysmally to answer the intended "defining" question, it was informative beyond the points noted above. In infinite innocence the writer had supposed that the word prevention would be an important high-frequency one in CMHJ. Accordingly, he checked all titles for kindred words such as "prevention," "prevent," or "preventing." Ten such usages (3% of all articles) were noted, which at first blush is disappointing. The second blush was worse, since of those 10 occurrences, 6 were preceded by the word suicide, one by delinquency, and two followed by "chronic illness" and "on campus," respectively.

A clearer picture of the evolving SC area can be obtained from Golann's very useful *Coordinate Index Reference Guide to Community Mental Health* (138). This volume includes a content-coded listing of more than 1500 references entered according to 125 topical areas, grouped into broader sections such as: concepts and theory, educational systems, and social welfare systems. Roughly 27% of the entries are coded as research reports; only 2% are coded "primary prevention."

The two descriptive pathways cited offer convergent evidence that the SC area has thus far largely ignored primary prevention and has failed to develop a strong research base. The latter observation has already been made by others (33, 308), though Roen justifiably urges patience, both because of the youngness of the field and the intrinsic complexities of research in the live social arena. Perhaps the most important message coming from this account is the diffuse quality of this young, volatile field. While there may be advantages, as some have suggested (192), to nurturing amorphousness during formative periods to avoid foreclosing options prematurely, some defining and crystallizing of core elements is needed if only to help soulmates communicate. The danger that such structuring will be too "narrow" is not overly grave. Whatever can be sensed about the SC framework tells us that its potential scope is enormous and that is it developing at a near-exponential rate (86, 193).

Prompted more by masochistic than scholarly reflexes, the author attempted to catalog recent volumes that may fit a loosely defined SCI framework. The hunt, less than exhaustive, produced more than 250 titles. A major grouping of these consists of broad overviews or surveys of the field, however defined by the authors (e.g. 1, 22, 23, 27, 30, 46, 52-54, 73, 86, 104, 105, 119, 132, 153, 216, 217, 221, 223, 305, 310, 318, 329, 362, 370). More specific subareas represented in this publication explosion include: 1. *Epidemiology, System Structure and Analysis, and Ecology* (e.g. 11, 19, 71, 72, 92, 100, 103, 107, 114, 186, 201; 230, 253, 254, 258, 262, 274, 319, 372); 2. *New Uses of Mental Health Manpower* (e.g. 2, 9, 41, 58, 59, 69, 109, 130, 131, 145, 150, 152, 155, 164, 245, 290, 334, 352).

If, instead of cutting the SC melon up and down according to structural domains, one cuts across to get at content areas such as schools and the poor, the number of recent books both stagger the imagination and make it impossible, even for highly motivated, well organized camp-followers, to keep pace. A few examples serve to illustrate the development: 3. *Schools* (e.g. 6, 36, 38, 39, 47, 70, 102, 115, 116, 127, 137, 174, 203, 222, 255, 259, 268, 312, 317a); 4. *Inner City* (e.g., 51, 64, 94, 97, 98, 122–124, 126, 146, 158, 163, 166, 169–171, 173, 190, 191, 205, 219, 282, 285, 288, 291, 298, 299, 304, 313, 353).

The rapid-fire citation of sources in the burgeoning SC field is intended less to dazzle the beleagured reader and more to convey a sense of the area's explosive growth and the attendant difficulties facing the reviewer who seeks to find order in chaos. Accepting the inevitable, i.e. that space will not permit grand progress through all of the labyrinthian byways of this remarkable can of worms, the rest of the chapter focuses on brief reviews of developments in several crystallizing subareas that seem destined to influence tomorrow's SC profile importantly.

UNRESOLVED MENTAL HEALTH PROBLEMS

An appropate foundation for further discussion may come from considering, if only in skeletal form, several core, unresolved problems besetting the house of mental health today. Over many centuries our concepts of disordered behavior have both broadened and come to encompass less florid, more subtle conditions than before. This inexorable trend, as suggested elsewhere (365), is multiply determined. In part it reflects greater diagnostic sophistication and ability to read complex intertwinings between emotional difficulties and other problems of living. In another measure it mirrors the technological evolution of Western civilization, the resultant increase in leisure time, and the growing likelihood that material needs will be met. Taken together, these social changes turn greater attention to man as a psychological being. Consequently, more people today than ever before are concerned with MH problems, broadly defined, and more social institutions (e.g. schools, industrial organizations, the military) have assumed responsibility for such problems because they relate intimately to individuals' behavior and performance in those settings.

All this adds up to an ever-growing demand for MH services—a demand that exceeds available resources now or in the foreseeable future. With a spate of epidemiological-demographic studies suggesting that need for mental health services far exceeds evident demand (2, 8, 9, 198, 224, 313, 337), it is fair to say that one significant problem facing the MH fields today is that they cannot meet pressures, expressed and latent, for help. Our most recent refresher course (198) tells us the same thing in slightly different form: i.e. nearly 1½ million children under 18 are estimated to need immediate professional assistance; less than 30% of them are getting such help.

Another order of problem, one which can be viewed at multiple levels (e.g. cross-sectionally or historically, by technology or by disordered conditions, etc), has to do with the effectiveness of MH activities. How successful, for example, have we been historically, or are we now, with so-called major mental illness including schizophrenia and other of the functional psychoses? Here the cumulative record shows that we have been remarkably ineffective either in advancing understanding or treating these conditions (42, 280, 322). A second pertinent concern has to do with the effectiveness, measured clinically and socially, of highly valued MH technologies as, for example, psychotherapy. Considerable data seriously challenge the imputed precision and effectiveness of this approach, even for the select few it reaches. More important in the social sense, distribution of scarce psychotherapy time is subject to marked biases—some explicit, some insidious—and, in the end, limited resources are disparately allocated to wealthier, better educated people from large metropolitan areas (180, 240, 315).

Many other MH services besides therapy are unevenly distributed. The poor attract less favorable prognostic judgments and it is more difficult for them to get any type of help. If seen, somatic and custodial interventions are more likely. Typically they are seen by less experienced personnel for shorter periods of time and with less positive outcomes (45, 129, 180, 240, 263, 315, 337). In practice then, MH delivery systems have resulted in help being least available and least effective for those who most need it. Additionally, serious questions have been raised about the appropriateness of middle-class services to the poor's lifestyles and ways of defining problems (43, 292).

Thus the MH professions have failed in important ways to cope with disordered behavior. Perhaps that phrasing is unduly harsh; it may be fairer to say that approaches which were once adaptive are no longer sufficient to the task at hand. And even though we can recognize these imperfections, change has been slow because viable alternatives have not been identified. The present challenge goes beyond expanding manpower pools, developing more effective interventions, or expanding reach. Though such measures would obviously help, if predicated on accepting dysfunction as a given, they would be too narrow. A conceptually preferable alternative is to *prevent* adverse outcomes, i.e. to engineer health rather than undo malformation. Effective prevention requires different skills and methods from those currently used by MH professionals; to realize its objectives professional training will need overhaul (213). Far from proposing a new set of interests to replace old ones, we are merely suggesting that many psychological problems cannot be effectively handled when crystallized and entrenched. If that is so, we require a qualitatively different conceptual stance to disordered behavior if its problems are to be solved. This point bears on the oft-cited difference between "community mental health" and "community psychology" (24, 192). The former tends to accept entities as givens and to use diversified community services and approaches to augment effectiveness in coping with them. The latter, however, is broader and more oriented to engineering health-producing settings and environments.

CONCEPTUAL ALTERNATIVES

Without having said so explicitly, the sense of the argument thus far is that the future of MH rests as much with its conceptual stance as with any other single factor. The term "conceptual stance" is used simplistically rather than rigorously to connote a loose network of guiding views and interlocking assumptions about how disordered behavior comes about and how best to cope with it (365). Such a stance permits policy makers to hierarchize and select from a vast array of prospective approaches; it is thus an orienting framework for making allocations in a finite resource system.

For many MH professionals the day-to-day work world is narrowly defined, and they have enough certainty and satisfaction about what they do to simply "tune-out" on conceptual "noise." They are far more concerned with the moment-to-moment effectiveness of their actions than with abstract, removed issues such as the overall good of individually useful but socially limited interventions. For other professionals, conceptualization is a crashing bore. Unfortunately, however, there is no such thing as *non*-conceptualization. One either conceptualizes planfully or by default. In the latter case, the field's conceptual stance is betrayed (operationalized) by the sum of the activities of its constituents. If 90% of MH activities are in psychodiagnosis, therapy, and institutional care, then *that* is the field's prevailing, if implicit, conceptual bias. Just as long as those requiring help and those who provide it are satisfied with what is happening, the system endures. As targets or providers develop concerns about what is (not) happening, or as new significant social problems potentially within the mandate of, but not addressed by, the existing system surface, its Godliness is challenged and alternatives draw attention. Today's unresolved MH problems set such ferment into motion. A prime thesis of this chapter is that the preventive pathway as a bonafide conceptual alternative necessarily leads us in SC directions.

MEDICAL MODEL

Simplistically, the major conceptual tracks available in MH are those of the "medical model" emphasizing repair and rehabilitation of dysfunction, and the preventive model which emphasizes building for health. Brief examination of the major features of these two models highlights the potential as well as the limits of an SC approach. But first, several disclaimers! The terms "medical" and "preventive" model are pure abstractions—perhaps even caricatures! While MH programs may incline in one or the other of these directions, they are most often impure and cross boundaries. Second, concerns about the medical model are directed to its failures in coping with MH problems and do not "put the finger" on particular groups as, for example, psychiatrists or others with medical training. To the contrary, the model is thoroughly panprofessional, and its orientations and practices equally well pervade the beliefs and activities of *both* medical and nonmedical MH specialists.

The most fundamental assumptions and most serious failing of the medical model in MH is the belief in a structural parallelism between the onset, nature, and treatment of psychological and physical dysfunction. This assumed analogy need not be literal in the sense of psychological disorder necessarily being caused by invasions of noxious agents, viruses, or pathogens (5). Psychological causal agents such as anxiety, rejection, and insecurity can be involved equally well. If the analogy is accepted, however, the MH specialist's prime aims are to identify the causes and minimize the effects of dysfunction. While there are surely instances where this parallelism is valid (e.g. brain injury or tumor, toxic poisoning) the core of psychological dysfunction is different (32, 351).

Most disordered human behavior differs qualitatively from the modal, short-term instance of physical dysfunction because it has deeper roots, longer germination periods, broader impact on many aspects of the person's functioning, and is shaped to a greater extent by significant people, experiences, and social institutions in the individual's history. Unfortunately, these differences have not been sufficiently respected, and in practice most MH professionals engage human psychic dysfunction when it is already evident, entrenched, and often has exacted a severe toll. At such times dysfunction tends to sustain itself and to resist amelioration. Given the firm rooting of problems over many years, resources that can be brought to bear on them are woefully inadequate. More than conceivably, dismal past failures in treating profound disorders such as schizophrenia can be attributed to unthinking acceptance of the faulty parallelism premise.

Another limit of the medical model grows out of the fact that emotional perturbation so far exceeds resources for dealing with it. This imbalance supports the traditional "passive-receptive" stance of MH practitioners (76, 365). Typically, the latter "set up shop" publicly or privately and wait for troubled individuals with crystallized problems to find them. This approach is faulty in two ways. First, because the professional sees people with rooted difficulties which are part of complex, functionally autonomous life styles, conditions do not favor optimal intervention. This situation is further aggravated because help-seekers tend, quite unrealistically, to see the MH specialist as a knowledgeable expert who, like the physician dealing with physical dysfunction, discovers causes and implements simple, direct, cause-related cures. Second, there is sharp selectivity in who the professional sees—i.e. those whose personal views, ways of defining problems, and means permit them to seek help from a high-cost help agent. As a result, major segments of the population in need fall outside the reach of MH resources.

Scope deficiencies of the medical model result both from what it actively does and what it does not do. The point has already been made that scarce MH resources are not evenly distributed across social strata. Equally significant is the fact that traditional MH practice is governed by "rules of the road," some explicit, many implicit, about what is and is not an "appropriate" problem for the professional to handle; where, how often, and under what circumstances the helper and helpee should get together; how the setting should be appointed; acceptable styles for proceeding with the business at hand; and ultimate objectives. These rules strongly reflect middle-class amenities, and as such do not always well fit the broad range of ethnic, cultural, and experiential backgrounds of people having difficulties. The "let-them-eat-cake" stance that many MH professionals have adopted is ill-suited to the moment. The challenge is not how we can get "them" to buy "our thing," but rather how issues can be reconceptualized and technologies modified to extend the helping professions' "clout" manyfold. Presently the core ways of the medical model are so alien to the poor that genuine help for them is impossible. The potential elasticity of the SC framework, by contrast, offers attractive options for extending the scope and impact of helping interventions.

None of the foregoing considers directly the effectiveness of basic medical model practices in MH. Raising this question spotlights concerns about the reliability and validity of judgments about personal attributes and pathological functioning and the effectiveness of interventions to ameliorate dysfunction. Both of these questions have been studied energetically in recent years, though the collective findings do not add up to an encouraging sum. Long-standing, dignified lines of research have called into serious question both the reliability and validity of psychological classification schema (10, 194, 199, 237, 247, 251, 252, 356, 368) and the accuracy, or predictive power, of clinical judgments (183, 207, 238, 344). Even more disconcerting is the growing body of evidence (332) suggesting that advanced professional training is unrelated, or negatively related, to accuracy of judgment about one's fellows. A recent study by Nathan et al (264) well exemplifies unfortunate "noise" in this area. In this research, 32 MH professionals, after directly observing a comprehensive diagnostic examination of an alcoholic patient, gave 14 different diagnostic judgments, ranging from temporal-lobe epilepsy to paranoid schizophrenia. Other studies point in much the same direction. Temerlin (345) had MH professionals and nonprofessionals observe a clinical interview with a healthy male oozing healthy behaviors. Subjects were told by a prestige figure beforehand that the interviewee had psychotic qualities. Both subject groups diagnosed him as seriously ill. Haase (160) asked two groups of comparably experienced clinical judges to rate Rorschach protocols. One group was given bogus case history materials indicating that the patient came from a middle-class background, whereas the second was given the history of a low-income person. Although the actual test records were identical, significantly more favorable diagnostic judgments were given for subjects thought to have middle-class backgrounds.

Mental health professionals do not agree on the extent to which interventions need depend on diagnostic judgments; and even where diagnostic judgments agree there is no necessary agreement about optimal intervention (342). The latter is more often determined by factors such as the professional's prior background and training, attributes of patient and setting, and the clinician's biases.

The question of the effectiveness of MH interventions is still being debated intensely. A recent scholarly review on therapy outcomes (28) ends on a note midway between the unbridled optimism of the early 1950s and the devil's advocacy of the later 50s and 60s (110–113, 231–233), ". . . the evidence continues to yield the general conclusion that psychotherapy, on the average, has modestly positive effects" (28, p. 228). This conclusion is limited to selectively narrow portions of both the population (i.e. those who are seen in therapy) and of the spectrum of disordered conditions (i.e. relatively less serious dysfunctions). Certainly it does not apply to more profound pathologies such as schizophrenia, which have consistently resisted enduring positive change.

Shortcomings of the medical model have not escaped attention, even from ardent supporters. Nor has this orientation lacked for dedicated, intensive effort to shore up its weak points. For planning bodies in positions of social responsibility, such efforts have focused heavily on expanding the model's scope so that services can reach the heretofore unreached. Thus we have witnessed strong recommendations of the original Joint Commission (197) to develop CMH centers and to liberalize views of who can serve as help-agents so as to broaden service networks, as well as the recent report of the Children's Joint Commission (198) with its powerful push for more extensive, effective children's services and its specific concerns about the problems of minority groups and the poor. Both reports represent sincere efforts to identify critical areas not previously reached by MH operations and to eliminate these gaps.

Practitioners and researchers, from different vantage points and using different methodologies, have worked diligently to improve the medical model's effectiveness. Many new approaches have recently been developed for the profoundly ill: e.g. day hospitals, night hospitals, foster placements, half-way houses, various milieu approaches, token economies and behavior modification techniques. And for the less disturbed, efforts to improve the model's effectiveness include the development and testing of various new, hopefully more successful, interventions such as: behavior modification, implosive therapy, a variety of humanistic, affect-releasing approaches, as well as structural technique modifications such as family therapy.

Such efforts in the absolute are to be encouraged! There are, and will continue to be, psychological dysfunctions with physico-organic bases or predispositions. There are also circumscribed, reactive conditions (e.g. bereavement and grief, crisis, critical new adaptations, and situational disorders) that fall appropriately within a medical-model framework. And, however effective alternative approaches may prove to be, they will not resolve *all* problems of disordered behavior.

Potential improvements in the medical model, however, are restricted largely to expanding its scope and augmenting its effectiveness rather than to correcting its pivotal, underlying assumption of parallelism between psychological and physical dysfunction. A less obvious but perhaps more important consideration is that MH resources are and will continue to be finite (3, 4). The wisdom of using them to shore up weak spots in the medical model must be judged against a fuzzy metric of long-term good that might come from alternative, potentially more socially utilitarian allocations.

The core of the argument can be summarized as follows: However understandable the evolution and ascendance of the medical model, however necessary that portions of it survive, however much we can improve its efficiency, it fails to deal satisfactorily with today's basic, nonpostponable MH problems, and as such it can no longer stand alone as the guiding frame for long-range planning. Reducing the flow of dysfunction is appealing as a conceptual alternative. If we cannot do this, we risk treading water until we drown!

PREVENTIVE MODEL

In classic public health terms the prevention empire has been divided into primary, secondary, and tertiary fiefdoms. Primary prevention in MH seeks both to forestall dysfunction by reducing rates of occurrence of disorder in the population at large over long time periods and to promote psychological health and well-being (314, 365). Primary preventive activities are targeted impersonally to groups and communities; once individual distress is identified, intervention is other than primary. To be effective, primary prevention must be actively oriented to the effects of environments and settings, particularly widely influential ones such as the home and schools, on development.

Secondary prevention (54, 76, 314, 365) seeks to stop relatively mild disorder from becoming prolonged and severe. This concept has been insufficiently disaggregated in the past and, as traditionally used, it embraces two distinct foci. One is exemplified by an orientation to children, as for example identifying manifest or incipient dysfunction in the very young and intervening to forestall further maldevelopment. The more typical sense of the term, however, and a strong emphasis of CMH centers, is reflected in efforts to detect an acute schizophrenic episode or an involutional reaction in the first several days, rather than weeks or months, of its unfolding on the assumption that it can be handled more effectively earlier. While both examples illustrate legitimate secondary prevention activities, they bespeak different foci, values, and resource allocations.

Tertiary prevention (76, 314, 361, 365) seeks to reduce rooted dysfunction and to minimize its residual effects. In any genuinely functional sense, the term is a misnomer; discarding it completely would serve the useful purpose of reducing confusion. The suggestion that the term be discarded is not meant to repress the underlying problems it addresses. Instead, it merely says that such activities are *not* prevention. So-called tertiary prevention activities should be justified in terms other than prevention, as for example the humanitarian goal of reducing human misery and discomfort. The latter is easy to opt for as an absolute; and if our world had limitless resources, continued pursuit of tertiary preventive goals would not have to be questioned. Alas, it does not and there is not only the eternal competition between MH and other fields for a "proper share" of society's allocations, but also keen internal competitition within MH among many absolutely worthy contenders. The issue MH planners face is rarely to make binary choices between worthy and unworthy options and virtually always to decide among many "worthy" possibilities. To opt for a socially less promising program in a finite resource system precludes developing a more socially utilitarian one. If, for example, in the name of humanitarianism, MH invested 100% of its effort in a crash effort to improve tertiary approaches, as perhaps suggested in the highly debatable recommendation of the original Joint Commission (197) that profound mental illness is the major unfinished business of the MH field, and if the consequence of so doing (even successfully) were to aggravate or fail to improve the plight of the many, it would mock the concept "democratic-humanitarian ethic."

Thus prevention is less unitary a term than what is suggested by its past traditional usage. The aims, methodologies, and programs of tertiary and late secondary prevention are entirely different from those of primary and early secondary prevention and are easily accommodated within a classic medical model framework. Highlighting this distinction and sharpening the implicit view that the term prevention should be redefined to include only primary and ontogenetically early secondary prevention provides a crisper conceptual alternative to traditional medical model approaches and an ideological frame within which to consider SCIs. The reviewer finds this position both defensible and prospectively heuristic.

Systems centered approaches.—People sharing common interests in the unfolding SC area have often made a useful distinction between system-centered vs person-centered (or social-action vs interpersonal-action) aspects of a broad preventive model (54, 76, 314, 365). In the section to follow these strands are considered further.

A systems focus is predicated on the assumption that human development, for better or worse, is profoundly, though not always obviously, shaped by a small number of key social institutions and settings. It also assumes that it is as legitimate for MH to try to promote sound development as it is to shadow-box against maldevelopment. As such, an orienting question that assumes prime importance is: "How *do* primary social institutions affect human development?" To date, such influences have largely been random rather than harnessed to build for health.

To understand the effects of settings on growth requires that we first develop systematic frameworks for *describing* settings—something we currently lack (21, 47, 157, 360). An important related issue is how to create settings or environments that optimize adaptation (317–319)—a question that has profitably been posed at the very broad level of engineering new communities (225, 272, 273) or for narrower, more specialized settings (141, 142, 319). Vital as such an emphasis is, another element of complexity is introduced by the ecological concern of man-environment interaction and its relation to adaptation (19, 20, 209–212, 214, 267, 308, 348, 349).

To understand the enabling and restricting qualities of social settings establishes a theoretical base for modifying them in health-producing directions. Even so, actual system modification is anything but a simple, cut-and-dried process touching, as it does, practical concerns of human security, vested interest, and entrenched ways of doing things. Fairweather (114) has contributed a significant volume on "experimental social innovation," an approach combining service and research elements to produce orderly constructive social change.

Epidemiology, the study of the incidence, course, and patterning of mental illness (308, 372), is another key tool of a systems approach. One author (34) has gone so far as to describe it as the "research base of primary prevention." Far from being a Johnny-come-lately, epidemiology is a venerable approach with deep roots in public health medicine, as perhaps reflected in Zusman et al's (372) compilation of a 1400+item bibliography on the epidemiology of mental disorder, just for a 2-year period. Important progress in preventing physical illness has come from the informed use of epidemiology by public health specialists. The challenge for MH is whether it can develop and use knowledge of the patterning, or environment-related qualities, of disordered behavior to prevent dysfunction. An even more intriguing possibility (34) is to develop an epidemiology of health.

The family and school are among the most important social systems that shape the child's development, since his early years are spent almost exclusively in those two settings. This basic view of the world as warm-cold, restrictive-enabling, menacing-supporting, and the interactive-coping styles he develops are crucially molded by experiences at home and in school. In contrast with the past focus on "malformation" and its antecedents, stronger emphasis is needed on understanding family interactions and school structures as these relate to positive outcomes. Hollister (181, 182) expresses this view in coining the word "stren" as an antonym to trauma to designate health-promoting, resource-building experiences. Hollister's justifiable plea is for the MH fields to orient themselves to engineering "stren"-producing environments and interactions.

An important harbinger of this approach is found in the recent volume by Lennard & Bernstein (226) which deals with family interactions both theoretically and empirically. These investigators identify core family interaction dimensions and explore their correlates by comparing family vs therapy interactions, normal vs pathological, and German vs American family interactions. Examples of important dimensions considered include: opportunities for age-appropriate socialization, harmony-discord, and encouragement of self-initiated vs responsive behaviors. Though not exhaustive, this effort has considerable paradigmatic value; it models the needed emphasis on a basic taxonomy of family interaction and on relation between interaction history and later healthy or unhealthy outcomes. At a more clinical level, Bolman (35) describes a range of preventive possibilities with families.

Despite the family's crucial shaping influence, practically it is easier to work in schools. This is so because schools bring many children together under the same roof simultaneously, they have a unified administration and the potential for varied system interventions and modifications. Hence more work has been done in schools than with families. The questions systems-oriented persons ask about schools, however, are structurally much the same as those asked about families (i.e. What are the basic dimensions, overt or covert, of structure and interaction? How do these influence learning and development? How can the system be modified to enhance these objectives?).

Sarason's recent volume (317a) offers a penetrating, thought-provoking analysis of how salient dimensions of the school environment can be conceptualized and described and of the inordinately complex issues involved in effecting meaningful change in such environments. His effort well illustrates the heuristic value of cogent conceptualization for future program development and research; at the same time it reminds us that principles of change in the schools apply far more generally to other social systems.

One profitable line of work, sensitive to the intertwinings of cognitive and personal development, has sought to develop curricula, educational climates, or experiences to optimize school development (29, 63, 239, 259, 275, 307, 324, 347, 369). To engineer school environments effectively requires both frameworks for meaningfully describing them and good hunches about their salient dimensions of influence. Fox et al's (125) work on diagnosing classroom environments takes an important step in this direction by providing a framework and some technology for describing classroom environments. Similarly, Gump (157) presents a model for naturalistic observation and recording of the booming, buzzing confusion of a 3rd-grade class, thus providing a frame for studying relations between events and subsequent behaviors. Susskind (343), having chosen school children's curiosity behavior as his criterion "weapon," reports a fascinating study in system analysis and modification. People connected with education place great (abstract) value on young children's curiosity development. The questions children ask in class are evidence of curiosity behavior. Susskind observed a number of 3rd to 6th grade, non-inner city classes, and recorded for 30-minute units the number of questions asked by children and teachers. Given the lip-service faithfully paid to curiosity, his findings are shocking! Whereas teachers averaged about 50 questions in these 30-minute units (the "record" was 200!), children collectively averaged less than 2. Indeed *total* child utterances, questions or otherwise, averaged only 7+ per 30-minute unit. Clearly what is said about curiosity as an abstract ideal and what actually happens are worlds apart. Further analysis of the content of teachers' questions indicated that they were predominantly "fact" rather than "thought" oriented. This prompted Susskind to "train" a small group of teachers in how to frame questions and how to lead discussions to promote student involvement. As teachers shifted from "fact" to "thought" questions, children showed greater curiosity behavior. Susskind's work exemplifies the analysis of a salient system dimension and its potential for constructive system change.

Ecological studies of schools as social systems, though not frequent, are important. Barker & Gump (21) have looked at the effects of school size, and Gildewell (135) has addressed the important questions of system linkages in the schools and their relation to distress. Kelly et al (cf above) have been active, both conceptually and empirically, in ecological studies of the high-school environment. Rate of exchange, operationally defined by annual student turnover, is the key independent variable in this longitudinal work, and students' exploratory behaviors are the critical criterion measures. Kelly's view, which now has empirical support, is that exploratory behavior is more adaptive in fluid, as compared to stable, environments. More basically, the approach seeks to optimize man-environment couplings, a valid objective with significant practical as well as theoretical implications. Awareness of the importance of system-individual matches upgrades the value of system analysis and systems-engineering roles, as opposed to the restorative ones, for school MH professionals.

The present limited focus on families and schools is not to ignore the significance of other social systems (e.g. legal, welfare, religious, etc). Rather it reflects the *prime* importance of the two selected in shaping development. To prevent psychological dysfunction the influence of these key systems must be understood better and used to optimize growth.

A critical limitation of a systems orientation is that the MH professional's background and training do not equip him well to deal with such problems (24, 76, 136, 193, 213, 365). Indeed, they sometimes inhibit him from even *perceiving* them. There are also other deterrents. Systems analysis and modification are broad-gauge, abstract, and futuristic, making it hard for the professional to see and have the gratification of direct relations between his inputs and observable positive outcomes. Since most things done to improve man's general lot are also likely to improve his psychological well-being, the fate of system modification is complexly linked with a broad wave of social (e.g. medical, technological, housing, job opportunity) reform. Too, such work may require social and political actions (54, 292–294, 298) for which the MH person lacks the requisite training, know-how, or "stomach."

While MH professionals do not yet have these skills, they do have a significant stake in framing issues and participating with qualified others in a communal search for answers. Again this says that MH training be modified to enable its products to engage ancient questions in fresh, promising ways, and that classic, prior professional alignments be reshaped so that political scientists, economists, urban planners, architects, and educators are more often future bedfellows.

Person-oriented approaches.—Assuming finite resources, greater investment in a systems approach would reduce, and probably change the nature of, interventions with people but not eliminate them. Mostly it would force more hard-boiled judgments about the probable impact (i.e. reach and social utility) of a multitude of prospective person-centered activities. Using the yardstick of potential impact, it can be argued that person-oriented interventions with the young (early childhood focus), those that occur at temporally influential moments (crisis intervention), and those that increase reach geometrically (consultation) are especially promising. Also, person-directed MH activities can be significantly increased through new manpower uses (e.g. nonprofessionals). Each of these developments is considered briefly in the sections to follow.

Early childhood focus.—Based on assumptions about the flexibility and plasticity of youth (190) which imply more favorable investment/payoff rates in work with the young, many believe that children should be prime targets of person-centered helping resources (198, 333, 365). One recent policy document (271) advances 116 general and specific recommendations in areas including prevention, advocacy, services, training, and research, all designed to promote child MH. Several comprehensive surveys (6, 137, 198) provide detailed information about maladaptation in children. Glidewell & Swallow (137), based on a review of 27 studies, indicate that about 30% of all elementary age children experience school adjustment problems, and that 10% have sufficiently grave problems to require immediate professional help. Kellam & Schiff (206) report that in some sections of the urban ghetto, school maladjustment rates approach 70%.

An important practical question is whether early difficulties are largely stable or transitory. If stable and ultimately damaging, help should be provided as soon as possible; if transitory, time may be as good an ally as any. In fact, data on this question are not entirely consistent. Some studies (e.g. 278) indicate that school maladaptation is largely unstable. Clarizio (67) reviews a series of investigations showing only moderate relations between child and adult disturbance. He concludes that child-adult continuity of maladaptation is well documented only for extreme early deviance and for early aggressive, antisocial behaviors.

Other studies, however, some retrospective and others longitudinal, yield different findings, attesting to the complexity of the issue. One such series (276, 277, 306), a model for dedication and perseverance, covers more than three decades. In this work, more than 500 adults—about 90% of a sample seen as children for clinical evaluation in the 1920s—were located up to 30 years later and reassessed. The combined incidence of alcoholism, psychopathy, and psychosis was about 60% in the clinic (E) follow-up group; significantly greater, by a factor of 3 to 1, than in a C group. Similar results were found for other disorders. Robins' book (306) zeroed in on adult sociopathy. Using varied criteria including antisocial behaviors, arrests, job achievement, specific symptoms, alienation, use of welfare services, and divorce rates, disruption was about four times greater for Es than Cs. The more severe the earlier difficulties, the more serious were the adult problems. Robins' findings generally support the view that early dysfunction predisposes to later more serious pathology. Several other retrospective reports yield similar data. Thus Bower et al (40) found, retrospectively, that adult schizophrenics had significantly poorer high school records than nonschizophrenic Cs, and Westman et al (358) found a high correlation between the use of MH services and facilities by young adults and nursery school maladjustment ratings for these same subjects 18 years earlier.

This issue has also been approached longitudinally by several investigators. Stennett (339) found that 4th–6th graders identified as having moderate to severe emotional handicaps got worse rather than better if left untreated over a period of several years. Feldhusen et al (117, 118) report that children identified by teachers as being aggressive and disruptive in the classroom at 6th–9th grades were achieving significantly less well than nonidentified peers 5 years later. Another series of studies (90, 364) using a screening amalgam consisting of social work interviews with parents, group testing, teacher report, and classroom observation, identified 1st-grade children evidencing early signs of school maladaptation. Follow-up of these youngsters at 7th grade (367) showed that their later educational and personal development were significantly poorer than nonidentified peers. Brownbridge & Van Vleet (48) used teacher ratings to identify maladapting young school children (kindergarten–4th grade), and found, over a 3-year period, that about one-third of the group improved spontaneously.

While these research findings do not readily summate, their sense is that unattended early dysfunction does not dissipate spontaneously. Though it is unlikely that all types of early difficulties have common destinies (acting-out, for example, seems to be more stable than undersocialization and shyness), the durability of serious early dysfunction justifies an emphasis on early detection and intervention. Such work may be facilitated by a recent burgeoning of relatively brief, inexpensive, easy-to-use mass-screening devices for early dysfunction (e.g. 38, 48, 84, 99, 256, 257, 286, 311, 312, 326). Although Caplan (54) warns that even the best early detection techniques are constrained by limits in providing help, in this case expanded, more efficient, screening technology is accompanied by parallel processes of redefining and amplifying helping resources (cf below) in ways that allow for more effective follow-through. Thus, investments in children merit high priority in distributing person-resources.

Crisis intervention.—Beyond an emphasis on children, several other person-resource allocations meet the criterion of high potential impact. One such, crisis intervention, rests on the view that, with important needs at stake, critical events result in multiplicative rather than simple incremental enhancement or damage to well-being (54, 93). If effective services are available during such periods, relatively small time investments may have high payoff, defined either negatively (i.e. averting disastrous consequences) or positively (i.e. building new strengths and adaptive resources). Caplan (54) observes that crisis, by definition, is so central and intense that significant change must result from it. The sense of the crisis intervention is to increase the likelihood that the change will be positive (34).

Crises, as classically defined (54), are brief, concentrated periods of disturbance, often characterized by intense upset, preoccupation, emotional churning, a sense of inadequacy, and openness to the input of other people. Several of these attributes, particularly the last two, suggest that people in crisis may profit from constructive intervention. Early formulations about crisis theory and intervention came from Lindemann's (235) work with victims of the disastrous Coconut Grove fire in Boston. Lindemann found that appropriate intervention during the critical crisis period could forestall later grave consequences. Cumming & Cumming (93) suggest that the elements which heighten crisis reactions are: suddenness, arbitrariness, and widespread disruption of the individual's life functions, while Caplan (54) emphasizes loss, or threat of loss, of essential psychological supplies as critical factors in amplifying the reaction. Death of a loved one, serious accident or trauma, and major change in heretofore stable life circumstances (e.g. loss of job, retirement, military induction or initial combat exposure) are all crisis-potentiating events. Specific techniques for intervening in crisis situations have been proposed (16, 54, 202, 235, 281).

An important practical distinction has been made between unanticipated crises, as the above, and normal, predictable ones (34, 93). The latter term refers to relatively common life events (e.g., birth of a new sibling, elective surgery, starting school, marriage), with high base-rate probabilities for eliciting crisis-reactions. McGee (249) argues cogently that intervention would be clarified and facilitated if we thought of crises as falling on a continuum of anticipability, rather than as absolutes. Certainly one can plan more effectively and be surer that adequate coping resources are available for predictable in contrast to sudden crises.

Erikson (108) offers a fruitful extension of the crisis concept in his view that personality development consists of a series of differentiated stages, each separated from the next by a transitional, crisis-prone period. Resultant epigenetic growth crises are relatively predictable and gradual. Effective handling of the transition-crisis strengthens resources and coping skills, sharpens one's sense of discrimination and control of the environment, and expands self-knowledge and knowledge of the outside world.

Extending the conceptualization of crisis to include both the anticipable and developmental varieties opens intriguing opportunities for actively entering the crisis arena with interventions designed to forestall pathology and build health (37). Cumming & Cumming (93), for example, propose a type of emotional innoculation in which individuals are given a graded series of crisis situations to work through under relatively protected conditions favoring positive resolutions. Their aim is to build specific crisis-coping skills, and with them build immunity to the potential toll of unanticipated crisis. Similarly, Caplan (54) proposes the use of "anticipatory guidance" to train people in crisis coping. This method, targeted to specific anticipable stresses (e.g. starting school), is built on the deliberate arousal of vivid anticipation of the experience and its surrounding negative affect. Opportunities to cathart and to express distortive fantasy are encouraged. As this happens, support and guidance are offered, alternatives are anticipated, and rehearsal of potentially adaptive roles and specific behaviors are encouraged.

If crisis periods indeed have significant adaptive consequences, for better or for worse, if individuals in crisis are vacillative and open to influence, and if effective crisis resolution depends on one's ability to perceive and choose among alternatives, then crisis intervention should have high priority among person-centered approaches in an SC framework.

Consultation.—Relative to the great amount written about it, there is far less hard research on consultation than any other emergent SC subarea. This not-so-curious fact bespeaks the diversity and impalpability of consultation activities. Entire volumes have recently been written about consultation—both general ones covering various aspects of theory and practice (55, 325) and scope-delimited ones dealing with such topics as the schools (115, 127, 268), community caregivers (328), or outreach to low population-density areas (151). The voluminous word output in this area has not escaped the attention of bibliographers, and there are at least a score of publications which are primarily reference listings in MH consultation, again either broadly (246) or for delimited topics such as consultation programs for children or in educational settings (244, 248). Collectively these documents, while helpful, are exhausting! For example, the consultation reference-guide by Mannino (246), limited to literature published between 1964–1968, includes more than 600 references classified by topics such as: fields of practice, forms of consultation, professional roles, process, and planning.

Both because many of these sources themselves contain good reviews of the nature, purposes, scope, and forms of consultation, and because of the strikingly low research output of this field [one recent chronicler (266) asserts that there are no more than six bonafide consultation research studies] the lazy reviewer, such as the present one, is tempted to throw up his hands in despair and say "Why bother?" Attractive as this alternative is, a minor remaining island of super-ego combined with an ill-formulated conceptual trace merge to keep him going. The paucity of research on consultation, though enormously disconcerting, is not disqualifying. If there is a place for this function in a grand SC conceptual scheme, then it should be considered here, even without a good research base,

Several major consultation sources (e.g. 55, 248) offer definitions containing as essential elements a knowledgeable MH professional communicating his know-how and expertise to individuals or groups who, despite a relative lack of MH training, are called on to engage MH problems in discharging their appointed functions.

To understand the place of consultation in the SC field, we must first recall the tremendous shortages in manpower and services, and must next examine how people deal with their personal problems. One of the reports of the original Joint Commission series (159) presents sobering data on this second matter. Roughly 25% of an interview sample admitted to having at some time had an emotional problem for which they needed help, and 15% had actually sought help. Among the help-seekers, however, less than 20% took their problems to MH professionals. The largest single subgroup (42%) went to clergymen, followed closely by family physicians (29%). Thus, even amongst those who explicitly seek help for problems *they* define as psychological, only a small fraction go to society's designated agents in this area. The messages coming from these data are that MH professionals are less the saviors of society than they consider themselves to be, and that by paying greater heed to reality rather than to how we think things should be, person-oriented deployments can be identified that vastly increase society's potential for dealing effectively with human problems.

As members of a communal society, most people have close contacts with friends, relatives, or co-workers, so that there are "outlets" for the minor difficulties that are a part of everyday living. More often than not these sources are effective (doubtless because they are part of a natural trust relation) and help to resolve problems before they root. Sometimes, however, the situation is more complex. Some people do not have parsimonious first-line help sources available to them. In other cases, problems are too difficult for the would-be helper to handle. Even then the person who needs help is less likely to turn to the MH professional than to any of a group of *non* MH specialists, such as clergymen, physicians, attorneys, and educators, whose societally designated functions put them into close, trusting relations with others. Such individuals have been called "caregivers" (54) because their ascribed social roles heavily touch people and the promotion of their well-being. In some communities without MH professionals, caregivers may be the only ones who can be called on for help.

Another group, including enforcement, legal, and welfare personnel, sometimes called urban agents (208), also become involved, often unpredictably or unwillingly, in peoples' psychological difficulties. Such individuals, who are even more removed from MH training and concepts than caregivers, have social roles that can at any moment bring them up against unfolding crisis or the raw nerves of human distress. Among the most fascinating work, including evaluation, done in CMH consultation and training with caregivers is that of Bard et al (e.g. 13–15, 17, 18), who trained police officers for family crisis intervention in deprived ghetto areas of New York City.

From the MH standpoint, the prime common attribute of caregivers and urban agents is that they are called on to help, or at least interact with, people in interpersonal distress. The circumstances under which this happens are varied. With caregivers the situation is often favorable in that problems come up relatively early in their development within a comfortable, established relationship. The urban agent usually lacks these advantages. He may not have a trust relation with the involved party at all; indeed his contact may be as a representative of an "alien" system (e.g. the police) and may occur during acute crisis rather than within the shelter of a long-term, close, personal relation. Whatever the circumstances, how the situation is handled is complexly determined by variables such as the potential helper's knowledge about and attitudes toward MH, role definition, background and experience, and personal style. Several of these factors, especially the first two, can be constructively modified by consultative input.

Not infrequently MH professionals have gotten a bit "uptight" about the likes of lawyers, clergymen, educators, and certainly police officers—people who have not gone through the professions' standard *rites de passage*—messing around with something so delicate as the human psyche. We can ill afford such sanctimoniousness! Far more realistic, and probably healthier, is the stance implied in the oft-quoted wisdom: "That's the way it is, man!" The MH professions simply lack the resources, personnel, and perhaps "know-how" to deal with manifest problems or latent needs. Also, established flow-lines bring the lion's share of such problems elsewhere. It is less productive to sit back and judge, in a vacuum, whether that which will not change is good or bad, and more sensible to develop ways to join reality—in this case to provide knowledge and support for, and to strengthen the hand of, those in society who regularly field human distress. This is a core aim of MH consultation.

The initial definition of consultation provided was broad and generic. More specifically, consultation seeks to: enhance the consultee's fund of information about MH facts and principles; increase his ability to perceive viable alternatives; broaden his awareness of potential psychological factors involved in many behaviors and situations; create a back-stop relation that allows the consultee to interact more freely and confidently with his "clients." Even so, consultation is far from a homogeneous entity. But although writers (55, 248, 365) dissect it somewhat differently, several key structural or content dimensions crop up repeatedly (e.g. individual vs group; client or case vs consultee vs agency-oriented; and clinically vs policy-planning oriented).

Little would be accomplished by exhaustive documentation of the range of applications of MH consultation. It is not much of an exaggeration to say that this form of intervention has by now touched virtually all types of settings, agencies, and social groupings that can be identified in modern society. Browsing through Mannino's (246) source bibliography, one quickly notes that consultation has not only reached face-valid, obvious groups such as teachers and other educators, physicians, pediatricians, clergymen, nurses, enforcement workers, welfare workers, correction officers, and the agencies they represent, as well as architects and urban planners, industry, the military, and local, state, and federal planning bodies (the writer apologizes to groups offended through inadvertent omission), but that it has also been trial-ballooned in less usual ways with judges, militant organizations, unwed mothers, and even in summer camps. Once having hit on the method, we have not been unimaginative in identifying applications.

Consultation's appeal rests on its enormous potential for addressing many serious MH problems, the most obvious of which is a sorely needed extension of reach. This can happen in many ways. A consultant by spending several hours per month with 10–12 clergymen or physicians, upgrading their skills, broadening their knowledge, and making them more effective interveners in human distress, can contribute to the well-being of many hundreds who regularly seek help from these caregivers for largely psychological problems. Consultation also expands reach by upgrading knowledge and skills of those working with groups (e.g. the inner-city disadvantaged) with which professionals can't even gain entrée. Also, consultation is a prospectively powerful tool for extending MH principles and services to isolated rural areas lacking MH resources. Such programs have been described (151, 188, 215, 336) and are becoming more frequent.

In addition to extending reach, consultation respects reality. Psychological problems are not foreordained to come to MH professionals. A given individual's problems end up where, and with whom, they must. In some settings problems are not even defined as psychological; instead, they are expressed as (and in fact often are) part of other complex problems of living. Consultation taking as givens, the loci and forms in which problems occur can embrace far more, and far more realistically, than what has ever been accommodated within MH's historically passive-receptive (i.e. "let *them* come to *us*") stance. It can thus be more socially aggressive—i.e. "relevant," in the cliché of the times. And however indirect, consultation is reality based in that there are many circumstances in which it is the *only* available approach.

For teachers, pediatricians, or others who have basic, regularized contacts with children during their formative periods, consultation's potential for building health rather than fighting pathology is distinctly visible. This may be its most important, if least explored, potential. As several writers have already noted, the prospect of applying behavior science knowledge and principles to engineering environments and social systems that optimize adaptation is an exciting one (212, 225, 273, 319, 348, 365). In principle then, consultation's advantages are enormous. The key unknown at this time is what they will be in practice when the data are in hand.

Nonprofessionals in mental health.—"Nonprofessional revolution" (334) is a term well coined—one that accurately describes a growing, highly influential development of the last decade. One measure of its scope is found in the sheer number of recent volumes about nonprofessionals cited earlier. This striking growth doubtless reflects society's urgently felt need to expand helping services and consequent willingness to explore new ways of intervening. Thus, the great strength of the movement lies in the new roles and expanding horizons that it opens for helping services; its gravest weakness is that it has grown more through evangelistic fervor than through critical research scrutiny.

The nonprofessional development has also been quite diverse in terms of factors such as helper groups, target groups, settings, roles, and functions. Once unleashed it has thus behaved much as the fabled adolescent maiden upon leaving a restrictive boarding school. Nonprofessional groups that have thus far served as help-agents differ markedly on many variables including age, socioeconomic status, education and training, prior life experiences, and position in the soical status hierarchy. The age continuum stretches at least from 6–85. Helpers have included the rich and the poor, those with little education and virtually no formal training, and those with considerable advanced specialty training, the ghetto-reared and those reared in posh suburbs, those whose roots and upbringing rest on society's basic pillars and those who have come the way of prisons, reformatories, detention homes, or institutions.

While early "high-impact" programs that opened the nonprofessional floodgates can be readily identified in retrospect, the development has probably been nourished more by a social readiness than by single influential programs. College students have been in the vanguard of the nonprofessional movement. From modest beginnings more than a decade ago through programs at Harvard (200, 352) and the Connecticut Valley State Hospital (184, 185, 323), in which students served as companions to chronic mental patients or lived with them in residential half-way houses, there are now more than 500 such programs (365). One particularly influential study en route (287) found not only that college students helped chronic patients significantly, but that they were *more* effective than trained, experienced MH professionals engaged in similar activities. While Poser's study has limitations (76, 309, 365), it nonetheless forces serious reexamination of perennial assumptions about who is qualified to work with and who can help chronic mental patients.

Continuing interest in college students as help-agents is reflected in the appearance this year of two research volumes (145, 290) and a comprehensive review of the literature (154) on this topic. There has been much "fanning out" in the use of college students from an original, relatively narrow base of work with adult chronic patients. Examples of this growth include programs for: hospitalized children (220, 295); children in out-patient and clinic settings (44, 95); using students as play therapists (236, 340); institutionalized delinquents (147, 316); children experiencing adaptive problems in the schools (77, 81, 91); and counseling other college students (371). Hunt (189) describes a flexible program using college students as companion-counselors for a variety of target groups experiencing adaptive problems: young children, adolescents, delinquents, dropouts. Cowen et al (82) have developed a human-services practicum in which undergraduates become involved in a broad range of community-based, helping activities with many different target groups. Mitchell (260, 261) has used college students in rural Vermont as traveling "outreach" companions ("amicatherapy") to children experiencing adaptive problems, in geographic areas where help is unavailable. In an ambitious, long-term program, Goodman (143–145) used college students as companion-therapists with emotionally disturbed 5th and 6th graders. Goodman pioneered the development of methods to identify more effective nonprofessional help-agents, work which has been continued and extended by others (65) and has explored optimal pairings of helpers and target-persons.

Gruver (154) notes the distinct lack of evaluation in this area and observes that the few studies that have been done are plagued by methodological failings. Based on limited data available, however, he concludes both that students are effective in helping roles and that they profit personally and by formulating career goals through serving as help-agents with distressed others.

Undergraduates are not the only student group to have been "impressed" into human service. For example, high school students have been used by Fellows, Walker et al (120, 355) as help-agents with preadolescent hospitalized youngsters, and by Perlmutter & Durham (284) as recreational aides with mildly disturbed children identified by social work agencies. McWilliams & Finkel (250) used "tuned-out" high school students as helpers with primary graders experiencing school adaptive problems. Neale & Mussell (265) report that more than 600 programs have been identified using college or high school students as tutors with the culturally disadvantaged, observing that such programs often have relational as well as academic components. A further, intriguing extension of the student development, comprehensively reviewed in a recent volume by Gartner et al (131), is the use of children, often very young, as help-agents (mostly tutors) with other children. Assumptions underlying this approach are that children learn best themselves when cast in the role of teacher, and the process of helping others in need is often a gratifying, growth-producing experience for the helper. There are now several schools in this country which require that children serve as teachers before they can graduate.

Students, however, do not have a monopoly on nonprofessional human-service activities. Another influential development uses housewives in a multitude of helping roles. Much of this work was stimulated by the pioneering effort of Rioch et al (301–303), who trained housewives to function as psychotherapists in school, hospital, and out-patient settings. Outside appraisal of the academic mastery of these women and assessment of their clinical effectiveness indicated that they were highly competent. Follow-up evaluation of their work 3 years later (245), reflecting employer, supervisor, co-worker, and self-data, supported the earlier competence judgment. Rioch's initial demonstration group was "special" in several ways. First, the women were bright, highly educated, and came from upper-middle class backgrounds. Second they received 2 years of intensive training from leading MH professionals. Later attempts to extend the generality of

Rioch's findings have been based on less well-educated housewives, on sharply reduced training, and have prepared the women for a broad range of helping roles. Thus, housewives have served as help-agents with chronic hospitalized mental patients in companion, therapeutic, and ombudsman roles (49, 62, 204); as workers in crisis telephone and suicide prevention centers (168, 179); as counselors on problems of youth (74, 75); as counselors in pregnancy and well-baby clinics (301); and as child-aides or help-agents in the schools both with children experiencing moderate (77, 78, 289, 331, 363, 366) and severe (101, 102, 270) problems. One report (88), carrying this approach a step further, describes consultative-supervisory roles that have been effectively carried out by experienced nonprofessionals in school MH programs staffed by housewife-aides. Hartog (165) reports a similar MH consultative role for nonprofessionals in a military setting.

A series of reports (7, 121, 156, 341) has been presented on "filial" therapy, in which parents are trained to work as therapists with their own children, first by watching actual therapists in action and later through being observed and discussed by parent-peers and trained clinicians. Related programs train parents for behavior modification work with their own children (167, 327, 354). Though a bit afield from the housewife-parent orbit, Carkhuff and Truax have reported extensive work in training for and evaluation of "lay counseling" (57–61, 350), including attempts to develop techniques for identifying the attributes of effective helping persons.

Several recent reports describe the use of retired persons as help-agents. Cowen et al (87) used such individuals as child-aides for maladapting school children. Such utilization has potential value both to helper and helpee and is one of the few avenues by which male identification models can be systematically introduced into the overwhelmingly female world of the primary grades. Johnston (196) reports another novel use of retired persons as foster grandparents to homeless children.

Omitted from this review, though also part of the broad nonprofessional helping thrust, is the massive "ex"-movement—i.e. using *ex*-patients, *ex*-offenders, *ex*-addicts, *ex*-delinquents, *ex*-alcoholics etc as help-agents for their fellows.

Apart from student and housewife-citizen programs, Arnhoff et al (9) speak of another nonprofessional development as the most important innovation, both in number and type, in MH services for the noninstitutionalized: the so-called indigenous nonprofessional, drawn from inner-city backgrounds and settings, for a variety of human service activities with the poor (e.g. 123, 124, 282, 294, 298, 299, 365). Complex and deep social roots contribute to the evolution and growth of the indigenous nonprofessional movement. One such is society's ever-growing awareness—fanned by dramatic instances of violence, protest, and militance around social problems—of painful couplings between adverse living conditions and unfortunate human outcomes among the disadvantaged. A second is the now well-recognized fact that standard MH services have largely failed even to engage the poor (180, 240, 315, 337). The few that do tend to be ineffective because they are seen as alien (43, 292). Thus there has been a bad match between the preferred individual-oriented, psychodynamic views of pathology of the middle-class MH establishment and the environmentally related, immediate, concretistic view of life's problems among the poor. Unemployment or the nonavailability of engaging, attractive job possibilities is one such critical problem. The indigenous nonprofessional development thus has two core, mutually supportive aims: (*a*) to bring sorely needed human services to the poor in meaningful, useable forms, and (*b*) to increase bonafide employment opportunities for the poor. This second goal is spotlighted by the influential New Careers movement (282, 299) which stresses permanence of jobs, even for the unskilled, and attractive career ladders to enable the talented to advance their personal and educational development, increase income, and improve life status.

Much has been written about why the indigenous nonprofessional opens genuine alternatives in inner-city health care and why he is, or should be, effective (130, 294, 299). Many potential advantages stem from the fact that he is an inner-city person. Having "been there," he understands and can deal with problems of his constituents in the forms in which they are expressed. He is likely himself to have experienced directly the high-frequency problems of the area, and knowledge of the realities of the local scene helps him to distinguish promising from illusory solutions. Because he is part of the group being served, his life style, modes of communication and interaction with his fellows, and "know-how" help him to gain entrée and win the confidence of his constituents—two significant barriers in the past to effective services for the poor. While the indigenous nonprofessional can be viewed as an effective bridge-person to professionals and as someone who can free-up professionals to undertake important new activities, the real potential of this new role comes from several other sources: promoting innovative, preventively oriented MH-related functions which the professional, for many reasons, cannot bring off, and changing realistically the nature of services to expand their reach significantly just where expansion is most needed.

We have lacked neither for willingness or imaginativeness in exploring new roles for indigenous nonprofessionals. Two heavy-impact, long-term projects, those of the Lincoln Hospital in New York and the Howard University Youth Studies Program (123, 124, 161, 218, 242, 243, 283, 297), describe aide-training for a variety of functional human-service roles in areas such as child care, housing, recreation, welfare, education, homemaking, and community action. In a recent comprehensive overview of this development, Gartner (130) reports an enormous range of activities by indigenous nonprofessionals in education, mental health, social work, health care, and corrections and enforcement. The role diversity of this group is made clear in a number of other reports (e.g. 66, 128, 162, 241).

Analysis of the functions performed by nonprofessionals in 185 programs surveyed (334) identified three major functions: therapeutic, special skill training, and community adjustment; and five lesser ones: case finding, orientation to services, screening, caretaking, and community improvement. Magoon et al's (245) review of the activities of a homogeneous group of eight housewife trainees turned up diagnostic, screening, therapeutic, research, and administrative roles. Merely on the basis of these two surveys, the great diversity of nonprofessional functions is apparent. Collectively nonprofessionals are doing virtually everything that professionals do; they are also involved in new activities not heretofore considered part of MH services.

Many authors who have written about nonprofessional programs (e.g. 8, 139, 152, 154, 155, 296, 300, 334, 365) have expressed views about why such programs "work" or have commented on their potentials and limitations. There are a number of expressed concerns, perhaps the most serious of which is Arnhoff's warning (8, 9) that mere proliferation of new MH manpower without seriously considering underlying conceptual-ideological issues or optimal patterns of use is not by itself a prospective solution for major current-day MH problems. Reservations have also been expressed that nonprofessionals are prone to such ineffectivenesses as excessive dependency, panicking, projecting one's problems onto others, lack of sophistication, etc. Such difficulties have surely occurred and will continue to occur. The individual or social dangers of these sins, however, seem far less grave than those resulting from mental health's chronic sins of omission (365). This development is also threatened by problems of limited job opportunities, shaky fiscal underpinnings of new programs, absence of well-defined advancement opportunities or career ladders, and loss of interest by host agencies in using nonprofessionals when cash layout is required. Furthermore, nonprofessionals sometimes suffer from lack of perceived status or credibility and may thus find their roles ambiguous. Finally, the movement runs the risk of encroaching on professional turf, with nonprofessionals being seen as low-cost replacements or "scabs"—a potential source of strong professional resistance.

The obvious appeal of the development comes from its twin potentials for vastly extending helping services and bringing genuine assistance to the many in society who have found prior packagings of MH goods unattractive. Among factors widely cited as important to the success of nonprofessional programs are the enthusiasm, vibrancy, and dedication of workers in what for them are exciting, new, real challenges; the naively positive expectancies they bring to situations previously viewed with pessimism and foreboding doom; the fact that in many situations they are better able to gain entrée and establish rapport because there is less social distance between helper and helpee; they are less encumbered by fixed but sometimes spurious rules and absolute "knowledge," permitting freer, unfettered exploration of diverse approaches; and they are less jargonesque and can thus interact more naturally with clients. And as a potential fringe benefit, many nonprofessional programs are found also to bring help to the helper, thus exemplifying convergent, mutually supportive resolutions of complex social problems.

A succinct, unequivocating, yet defensible summary for an area as complex and rapidly unfolding as this one is a sheer "pipe dream." It is not that such summaries haven't been ventured (e.g. 130, 334); rather they weigh much too heavily on soft data and glowing impressions from those who are actively caught up in the swirl of events. As such, the reports resemble the tidal wave of enthusiastic case testimonials in the early, golden days of psychotherapy. The fact of the matter, however, is that we are, as Sobey put it, in the middle of an nonprofessional "revolution." Events are moving with great speed, and for the moment our chips are placed on *exploring* an exciting, challenging, new world of usages rather than on hard-nosed evaluation. This balance will have to change before a trustworthy reckoning can be reached.

APPLICATIONS TO SETTINGS

Past approaches to disordered behavior have, as noted, characteristically been organized around certain entities of dysfunction, which have been taken as "givens." The list of admissible entities has changed, mostly broadened, over time (365), but whatever its nature, the prime job of the MH professions has been to classify people according to some prevailing entity system and to do what could be done to help with the best available tools of the time. The insufficiency of this approach is well captured by Winston Churchill's most famous quote from another time and context: "Too little and too late!" Its persistence and ascendancy for so long in man's history is due largely to the absence of genuine alternatives.

However much the SC framework lacks clear articulation and empirical footing, it is at least a viable conceptual alternative to past dominant approaches. Its core aim is to cut down the flow of disorder—to prevent. As such, it necessarily turns attention away from fixed entities or "end-states" toward the primary institutions and social settings that shape development. A key objective is to engineer environments and to create programs that hold promise of promoting the well-being of the many. This view implies that varied adverse "end-states" (e.g. neuroses, psychoses, alcoholism, addiction) have common, or at least overlapping, roots and that effective SC implementations could simultaneously reduce the flow of many conditions currently considered to make up the core of disordered behavior.

This type of value judgment forces one to readjust his spectacles. It suggests that it is every bit as promising, even for those with ultimate concerns about disordered behavior, to think in frames such as: "family organization and interaction," or "school environment," as the more rutted ones of psychopathology, psychodiagnosis, and psychotherapy. In the section to follow, such an approach will be "modeled" by considering paradigmatic, evolving programs in two critical settings-areas: the schools and the inner-city. These may be especially good examples because both touch many people, mirror pressing current social problems, and have attracted widespread recent interest.

An ancient European wisdom, roughly translated, says that: "When the emperor has to 'go,' he too must get there by foot." Similarly, real-life SC programs are considerably less noble and lofty than what may be implied by prior pie-in-the-sky theorizing. Effective conceptualizing can proceed in the smallest room in one's house! By contrast, programs are set in harsh, cruel, reality-constrained worlds; they must meet and negotiate the trials-by-fire of budget, politics, vested interest, and providing effective services to meet real needs. These are no mean hurdles! Thus, even the most brilliantly conceived and executed SC program is likely to be more restricted in scope, more targeted to the vulnerable, less systems-oriented, and less removed from a classically defined medical model than a theoretical ideal.

SCHOOLS

In our society adaptation to school is a critical stepping-stone to many important later life adaptations. Failure to adapt is frequent, as we know (137); it comes in all sizes, shapes, and intensities. The variety of sanctions and correctives attempted in the face of maladaptation is legion; yet we know relatively little about their effects. One recent essay (227), for example, suggests that the single most widely used educational corrective, nonpromotion, is completely ineffective.

Though teachers and other school personnel remain individuals in how they perceive and deal with school adjustment problems, one can nevertheless identify a step-stage progression of approaches spanning a hypothetical parsimony continuum (79). It is most parsimonious to engineer settings that optimize adaptation in the first place. Next, approaches that enable teachers to deal effectively with problems *in* the classroom are preferable. Considerably less parsimonious are appeals for assistance from some higher power (within or outside the school, as resources dictate) and environmental manipulations (i.e. changing the child's classroom or school) designed to "manage" him better. Least parsimonious of all are shifts which essentially give up on the child by turning over his education or management to an outside agency. Such steps not only rupture the child's contact with his natural environment, but may also label him irretrievably as a misfit. The programs cited below begin at various points in a school maladaptation process, each starting with its own set of "realities." At one extreme, the given is the child who is so disturbed that he has been excluded from school; the other is represented by far more "preventive" efforts for children who are not "at risk."

Hobbs et al (176–178, 234, 357) have pioneered the development of Project Re-Ed for seriously disturbed, excluded children ages 6–12. Re-Ed is a short-term, residential program built on the assumption that good education is the best form of therapy. Its motor force is a new breed of help-agent called the teacher-counselor who lives with the children around the clock and is responsible for their educational and personal development. The program (176) pivots around effective use of the full day to promote learning and adaptive skills, develop trust relationships, train for impulse management and competence, control symptoms and negative behaviors, promote group participation, and enable children to experience some measure of gratification in life. The average length of stay in the program is less than 6 months. Care is taken both to minimize disruption of the child's ties to his home environment and to plan for his earliest return under effective functioning conditions. One of Re-Ed's prime strengths is its carefully planned and executed research program (357). Parent and teacher evaluations, as well as school performance data, have shown significant improvements in Re-Ed children.

The Elmont project (101, 102, 270), like Re-Ed, is targeted to profoundly disturbed, e.g. schizophrenic and brain-injured, children 6–8 years old who are normally excluded from schools. In this case, program facilities, resources, and personnel came entirely from an intense mobilization of community effort. The principal help-agent in the Elmont program is the "teacher-mom," a volunteer nonprofessional who works with the child in an out-of-school, community-setting while he continues to live at home. As with Re-Ed, the program is built around the premise that good education is good therapy; accordingly its backbone is an entirely individualized relation between the teacher-mom and the child. The program uses bridge-people to maintain close contact with home and school and to prepare for the child's early, effective restoration to normal classroom functioning. Because of the seriousness of the problems handled, the average stay in the program is about 2 years. The Elmont program is both less fully and less carefully researched than Re-Ed. However, 11 of its first 21 children returned successfully to their regular class and continued to make normal progress in follow-up.

The Lafayette-Wyandotte project (312) is for children experiencing less serious emotional handicaps or school adaptation problems than Re-Ed or Elmont youngsters, though it shares philosophical assumptions (e.g. education as therapy) with those programs. Children seen in this program, in small groups of from 5–10, include the anxious, the immature, the withdrawn, and some with minimal brain injury. The teachers who staff the program first receive intensive, specialized clinical training. As part of the program they seek to tailor the teaching environment flexibly to meet individual needs in ways that respect the child's reality, reduce stress, help children to acquire social skills, foster effective peer contacts and a sense of group belongingness, and promote success experiences. An important research finding, based on factor analysis of a comprehensive preprogram test battery, is that not all children profited equally from the experience. The ones who did best were the initially "maladapted" (i.e. spatial disorientation, poor coordination) and unassertive types. This research suggests that it is an oversimplification to think of a single "Dr. Ehrlich's magic bullet" for all problems of school maladjustment. Instead the need is to identify and match taxonomies of dysfunction and intervention.

Other innovations in school MH are less oriented to the extreme casualty and are more concerned with lower risk groups or populations at large. Indeed several such preventively oriented programs (133, 172, 289, 330) by-pass direct contact with children in favor of parent discussion-counseling groups, sometimes led by trained lay leaders. Data have been presented (133, 172) indicating that such indirect intervention can produce positive change in the child's school adaptation or performance.

Based on mass-screening procedures, the Pace I.D. group (48) identified a large sample of primary graders (kindergarten–4th) evidencing serious school maladaptation. Social workers, assigned to work intensively with these children, observed them in school and met often with parents and teachers to further understanding of the child's difficulties and to develop effective helping procedures. Thus they coordinated planning for the children, served as a communication bridge, and expedited direct services where necessary. Program children were found to have improved significantly more than Cs. The Rochester Primary Mental Health Project (80, 83, 89, 90, 364) also focuses on early detection and intervention for school maladaptation. Mass screening, carried out primarily with first graders, uses a combination of social work interviews with mothers, group evaluations of intellectual and personality status, classroom observation, and teacher report. Housewives called child-aides are the prime help-agents, working individually and in small groups (80, 346) with children experiencing educational or behavioral (e.g. acting out, withdrawal) problems. This model permits geometric expansion of the helping arm (80). It has been shown that E-children in this program do better educationally and interpersonally than Cs (80, 90) and that these gains endure over time (85, 367).

The Sumter Child Study project (269) for preschool children more closely approaches an ideal of prevention. Two sessions were conducted for the families of more than 500 children 6 months before first grade entry. In the first session a psychologist did structured observation and testing with the child, while a social worker interviewed the mother. In the second session impressions and formulations were shared with the mother and, where appropriate, interventions for identified problems were planned. These interventions included such things as academic readiness programs, speech correction, social skill training, and providing regular preschool experiences. Research showed that screening impressions had high prognostic validity and suggested that the interventions laid the groundwork for improved school adaptation.

Programs cited in this section are far from homogeneous either in aim or method. Whereas some clearly retain the imprimateur of the medical model, others are more preventively oriented. This is understandable in that each starts with its own "given" and particular target situations. On the other hand, they share important common elements which can be explicitly noted. All deal with very young children and seek to identify and do something constructive about dysfunction as soon as possible. Notwithstanding real differences in the initial status of children seen through these programs, the values of solutions that minimize irreparable labeling and/or separation of the child from his natural environment are present. The programs share the conviction that the education process itself, rather than treatment, is an approach of choice in furthering intellectual and personal growth. Accordingly, educational function is a face-valid criterion of program effectiveness. The programs reflect awareness of the complex, transactional nature of the child's world and the need for communication and coordinated planning among the many who are charged with his well-being. Finally, at least several of them rest on intriguing, seemingly effective, new manpower uses, both the novel use of nonprofessionals and the development of new, socially utilitarian professional roles. Together these programs offer a viable alternative to past-prevailing modes for dealing with school maladaptation.

INNER CITY

Few topics in any field, let alone psychology, have generated as much recent interest as the manifold problems and plight of the poor in America today. Earlier in this chapter, it was not difficult to tick off the titles of some 25 quite recent volumes with a prime focus on some facet of the even narrower topic of relations between poverty and MH. These volumes and their surrounding literature contain the seeds for more than a few literature reviews (198). The reasons for opening Pandora's box, however, are that problems of the poor so well exemplify the challenge to an SC framework, highlight differences between it and more classic intervention modes, and point, if only illustratively, to exciting, prospective program directions. If psychological knowledge is to be applied meaningfully to social problems, this is one area that must be central to the "action." It would, however, be naive in the extreme to suppose that MH professionals stand alone as the "chosen" ones, or even as front-runners, in the quest for solutions to these complex, deeply rooted problems. Actions and interventions designed to improve the lot of the poor must be built on an understanding of inner-city problems, how they are expressed, and their intricate network of determinants. Often, even in cases with clear psychological components, such problems are not perceived as psychological; if they are to be engaged at all, they must be engaged in their own terms. Surely this is not an area in which to exercise professional "preciousness" (318). Progress in overcoming the oppressions of poverty demands joining high level skills and knowledge from many disciplines and groups, plus a genuine social commitment, backed by necessary resources, to get the job done (198).

Though the magic wand in this case does not belong to MH, conceivably some of their number, especially those who are able to orient themselves in this direction and rise to the challenge, can contribute to the long, difficult search for answers. There is reason to believe that this process is well under way. The section to follow describes, again only illustratively, some innovative recent steps taken by MH professionals, operating from an SC base, to do something about the thorny problems of the poor. As in the preceding section on schools, they span a continuum anchored at one extreme by out-and-out repair and at the other extreme by something approximating prevention. As an aid to exposition, these programs are grouped under the rubrics "developmentally oriented" and "inner-city action" programs.

Developmentally oriented programs.—It has been documented many times, by individual study and compehensive review, that the children of poverty are at risk physically, nutritionally, educationally, and psychologically (31, 190, 198, 365). Psychological risk is meant to cover not only the immediately obvious MH area but also such things as perceptual, cognitive, language, and motivational development. The fact of certain performance differences between the disadvantaged and nondisadvantaged in the latter areas has been less a matter of debate than the reasons for it. The monumental survey by Coleman (70), for example, established that 85% of black children in America score below whites on standard measures of educational achievement. But why? Is this due to adverse early environment, genetic differences as implied in Jensen's (195) highly controversial paper, inferior education as connoted by Clark's (68) notion of school "defeatism," or invalid assessment criteria?

The recent work by Baratz (12) and the penetrating analysis by Horowitz & Paden (187) bring another perspective to the issue. These investigators, without ignoring empirical fact, observe that findings can be prematurely construed to demonstrate "deficit," especially if one unquestioningly uses immutable white middle-class standards as the evaluation metric; but the findings can also more realistically and heuristically be interpreted as "differences" when multiculture evaluative standards are applied to the groups in question. Hunt's view (190), though it speaks to a somewhat different aspect of the problem, is unequivocal: ". . . the new evidence no longer makes it sensible to consider the incompetence of the children of parents from a background of poverty, be they black or white, as an inevitable consequence of their biological constitution and inherited nature" (p. 189).

The signs of less fortunate early psychological development in the disadvantaged are not usually found by scanning referral lists in clinics or consulting rooms. These are more likely first to be noted when the child starts school, and they often become increasingly apparent over time in that setting. If, as most believe, "cutting it" in school is a necessary precondition to a broad range of critical later life adaptations, then it is important to create circumstances that facilitate this for all. For the disadvantaged, this points to the need for three complementary approaches: constructive engineering of environments—the task of primary prevention; adapting educational approaches to the realities of preentry experience; and very early identification and intervention designed to build adaptive skills.

"Compensatory education" is a widely used generic term to describe a variety of preschool educational enrichment programs (171, 291, 359). Project Head-Start, about which much has been written (170, 171, 187, 190, 198, 291), is by far the most massive of these efforts. Head-Start's mandate is to enhance the physical, educational, and psychological development of disadvantaged children. While as Hunt (190) says: "The goal is right; the direction is right" (p. 159), the basic mandate is so broad that the program has been more a hydra-headed monster than a reasonably unitary entity. Although there are, to be sure, many examples of specific Head-Start projects which have produced important gains in, for example, reading or language skills, the facts that the "program" was set up for social action rather than research, and that its emphases are so diverse, have defied systematic evaluation. Indeed, some (190) have suggested that

Head-Start's best outcomes have to do with medical care and social development rather than skill preparation or educational growth.

Thus, in order to assess the potential of early enrichment and simulation, more circumscribed programs for preschoolers and infants, with more specific objectives than Head-Start, must be considered. Since this has been a major focus of at least several recent volumes (98, 173, 190), only a few illustrations are given here. Among the most straightforward of these is a program described by Bereiter & Englemann (25, 26), who believe that the key problems of language and reasoning deficiencies in the disadvantaged are best approached directly, as if English were to be learned as a second language. Their project for 4-year-olds, which has widely influenced the mass media, builds through five basic training steps: verbatim repetition, yes-no questions, location tasks, statement production, and deductive reasoning, hierarchized roughly in difficulty. Training proceeds quickly in a context of repetition, drill, and discipline. These investigators report rapid skill-acquisition and have demonstrated measured IQ gains of between 10 and 17 points for preschoolers and kindergarteners. Program children significantly exceeded matched Cs in reading and spelling.

The Peabody Program (148, 149), framed around intensive, 10-week summer preschool experiences for markedly disadvantaged youngsters, has both motivational and skill components. Motivational objectives include promoting an achievement orientation, learning to delay gratification and to persist, and developing school-related interests, whereas skill training emphasizes perceptual, language, and concept development in the context of a stimulus-rich environment. Over the 27-month preschool project period, Es' IQs increased by about nine points, whereas Cs' dropped six points. By first grade, however, Es began to lose ground.

A program at the New York Institute for Developmental Studies (IDS) (96, 338) explored the use of a therapeutic curriculum over a 5-year period with disadvantaged slum children. Training in reading, language, arithmetic, science, and concept-formation was featured, backed by a program of generalized cultural enrichment. The IDS project adapts to the individual child's current developmental status, and builds its training around specific, identified areas of deficit. Es were found to exceed Cs on measures of IQ, language development, and self-image. In summary, Hunt (190), based on a review of 20 specific compensatory education programs, states that *all* academically oriented ones have demonstrated gains in academic skills for their enrollees.

The observation (50, 187) that the first 3 years of life are overwhelmingly critical for shaping the development of children, particularly the disadvantaged, has led to a number of experimental studies in infant stimulation. Indeed, there have already been several reviews of such work (187, 190, 338). Illustratively, Caldwell (50) established a day-care unit to work intensively (i.e. 6–9 hours daily, five days a week) with infants as young as 6 months. Caldwell's program is designed to promote perceptual, sensory, and cognitive development and is built around activities such as listening, observing, ordering and classifying, coordinating and relating, memorizing, concept-formation, and problem-solving. The program also seeks to enhance personal growth, self-concept development, and acquisition of social skills, as well as to provide a broad range of culturally relevant knowledge. Significant IQ gain and growth in social competence were reported for children in the program 3 months or longer.

Another program (335) used college students as help-agents with ghetto infants, ages 1½–2½ years, experiencing marked slowdown of social and language development in the absence of of known neurological or physiological impairment. Enrichment, stimulation, language modeling, and shaping of prosocial behavior were the key program elements. A significant IQ gain of about 15 points over the 5-month program period was reported for an initial pilot group. Evidence of gain-erosion was again noted after the program ended.

Several other programs with comparable objectives are set in the home. Schaefer (320, 321) used daily home visits by college-trained tutors for a group of inner-city infants, ages 15–36 months, in an attempt to foster language development during its critical unfolding period. Tutors established close personal relations with their charges, played games with them and read to them and took them on excursions. In addition to language-tutoring and modeling, they also engaged in sorting, classifying, building, and musical activities. Es scored significantly higher than Cs on IQ, perceptual, and picture vocabulary tests at the end of the program, due mostly to a drop in Cs' scores, but these gains began to decay after the program ended. Painter (279) also used daily home-visiting tutors with a group of 8–24 month old disadvantaged children. In his program, tutors engaged in a variety of activities designed to foster intellectual and language development. On IQ and language tests, Es significantly outperformed Cs.

Gordon's (146) project, training indigenous low-income mothers to function as "parent educators" with mothers of other disadvantaged infants, is among the most ambitious in this area both in scope and research. Lectures and large group discussions, i.e. the middle class "route," were less effective as training devices for this group than role-playing, field visits, small group discussions, and on-the-job experiences. Parent educators were given both specific task training and training in methods of engaging infants. Task training heavily reflected Piaget's view of sensory-motor development and included items relating to object permanence, organization of body schema, and conservation. Training was also given to encourage labeling and the use of action words. The parent educators worked with 216 families with children between 3–24 months. About half the infants started the program at the age of 3 months and the rest at 1 year. Early starters significantly outperformed Cs on the Griffiths Scale of Intellectual Development. The same was true at the end of the second year, both for the early and late-starting Es in comparison to Cs. However, early starting Es who discontinued at age 12 months were not superior to Cs at age 24 months. The importance of Gordon's work lies not only in demonstrating the effectiveness of the indigenous low-income help-agent and the significant contribution of early stimulation, but also in underscoring the importance of continuous programming if gains are to be maintained.

The internal consistency and weight of the findings reported in this section add to an exciting sum. These studies tell us that dramatic cognitive, linguistic, and social growth can be brought about in young disadvantaged children in relatively short time periods. Hunt (190) clearly senses the import of these data:

> If the behavioral sciences have discovered anything that begins to approach in human significance the antibiotics and contraceptive pills of the biological and medical sciences and the atomic energy of the physical sciences, it may well be the new evidence of the great plasticity in infant and early child development. This new evidence provides a basis for a justified hope that the cycle of poverty can ultimately be broken (p. 232).

A warning note, however: a battle may be won, but not a war! It would be a mistake to ignore the fact that many, if not most, of these studies report sharp erosion effects when the program ended, suggesting that the difficulties of the young disadvantaged are sufficiently complex and deeply rooted that encapsulated short-term interventions may only be palliative. If the full promise of these programs is to be realized, they will require firmer anchoring both cross-sectionally, by improving ghetto living conditions and by greater family involvement, and longitudinally, through continuous intervention during the critical preschool period.

Action programs.—Although developmentally oriented programs are theoretically attractive, they do not directly address massive, nonpostponable problems of ineffectiveness, human waste, and social conflict that beset America's inner-cities today. The tried and true ways of the middle-class MH establishment have scarcely dented these problems; hence we desperately need promising alternatives. Concrete examples of innovative stirrings along these lines are cited in the section to follow.

Goldenberg (140–142) developed the Residential Youth Center (RYC) as a new type of setting to promote development in inner-city problem youth. RYC reflects the belief that the critical factors in determining whether or not the poor will be helped have to do with how settings are engineered rather than having specified services available to them. RYC rests on three assumptions: (*a*) that the problems of the poor can best be solved on their own turf; hence the program is located in a converted inner-city rooming house; (*b*) that committed, indigenous nonprofessionals are more appropriate change-agents for the poor than professionals, and hence RYC is staffed by ghetto alumni; and (*c*) that decision-making power should be vested in line-staff and residents rather than in vertically ascendant "top-brass"; hence all duties that are part of its normal function are shared by staff and residents, counseling is done by all staff members, and residents participate in RYC's operation and governance. The Center's atmosphere is home-like and open. Peer interaction is encouraged, as are self-help and realistic, personal goal-setting. Residents contribute to their room and board.

The RYC serves about 25 youth ages 16–21 at any one time. Their average stay is 5 months. A comprehensive research program compared resident Es to Cs, 9–12 months after the program's start, on a broad series of measures, including a number of face-valid (i.e. those defining past life-failures) behavioral indices. Es had dramatically better employment records, higher income, and fewer arrests, incarcerations, and days in jail. These hard data were supported by significant decreases in alienation and authoritarianism, greater trust, and a more positive view of the world, each significantly favoring Es over Cs. Thus, RYC stands as a model of an innovatively engineered community setting with demonstrated potential for producing constructive change in hard core ghetto adolescents not reached by traditional MH services.

The Howard Institute for Youth Studies (IYS) program (124, 218, 242, 243) models another SC alternative for multiproblem, hard-core, unemployed youth—i.e. the otherwise losers—ages 16–21. All trainees, whatever their ultimate role, received "core" training which included: learning more about oneself, the immediate community, and the world at large; acquiring basic skills in observation, recording, use of supervision; and knowledge of community agencies and relations. This training was supported by counseling, direct educational experiences, peer feedback, and discussion of actual observations from job settings. An important aim of core training was to build flexibility into the program. Skill training was also provided, using tasks required for specific jobs as major instructional tools. Trainees in IYS were prepared for a variety of human services functions, some noted earlier, in enforcement, social service, education, recreation, child care, health, and mental health. An important aspect of the program was the development of attractive job opportunities with career ladders in diverse community settings. Depending on the program and the skills required for job entry, training, always full-time, lasted anywhere from 3–9 months.

Four of every five trainees starting the program finished it and were successfully placed—an encouraging datum. Follow-up 2½ years later (124) demonstrated that the unemployment rate of the group had dropped from 90% to 13%, that delinquent acts had tapered off sharply, being limited to a total of 15 acts by 8 trainees in the post-program period, and that one-third of the group had gone on to further education (124). The IYS program, engaging a chronic, knotty social problem, effectively reduced antisocial behavior in a hard-core group and harnessed its talents productively.

The Neighborhood Service Center (NSC) (283, 297) is another inner-city SC model with major impact. The NSC was set in the South Bronx, an overwhelmingly slum-blighted area of one-third million, characterized by low education levels, high poverty, unemployment, and welfare rates, and a surplus of all major social problems imaginable: homicide, suicide, separation, divorce, delinquency, addiction, venereal disease, and admission rates to mental hospitals and other public institutions.

Before 1963 the area had no MH services, in part because traditional services turned off the poor. The aim in engineering the NSC (297) was to develop a setting that capitalized on the environment's profile and met real needs of the poor in realistic ways. More specifically, NSC sought to: provide and expedite MH services; increase neighborhood cohesion by reducing powerlessness and foster-ing social action; and initiate institutional change, especially coordination and improvement of community services. The original NSC, set in a street-level store front and manned by a director and team of indigenous neighborhood nonprofessionals, served an area of five square blocks with 50,000 people.

A nonprofessional staff, the program's backbone, was recruited from the neighborhood. It consisted of people who knew the area thoroughly and whose interest, warmth, orientation, and style qualified them as help-agents in this arena. Initially NSC focused on direct, palpable, individual services such as providing information, making referrals, taking clients personally to agencies, writing letters and filling out forms for them, coordinating agency services, and offering direct counseling and "psychosocial first-aid." Two reasons motivated this initial concrete service approach: (*a*) the evident need for such services was great, and (*b*) to establish a footing and sense of trust as necessary bases for later, action-oriented activities. Beyond individual services, NSC activated the community to develop a self-help orientation as a pressure against ineffective neighborhood institutions. The assumption was made that participation in self-improvement activities would promote a sense of dignity, involvement, and stake, while reducing dehumanizing feelings of helplessness and powerlessness. A number of social-action programs evolved, including: voter registration and block cleanup programs; antidrug, antiviolence activities; collaborative ventures with neighborhood schools, housing, and welfare organizations; and protest campaigns against local agencies that failed to meet residents' needs.

Evaluation of NSC is complicated by its breadth and unorthodoxy. The most important "pay-off" criteria for this program would be the prime sociological-demographic variables noted earlier in characterizing the South Bronx region. Obviously, such variables are also affected, in unknown ways, by other social reforms. Data are, however, available indicating remarkably high initial utilization of NSC services. New case flow exceeded 500 people per month in the NSC's first 6 months of operation. Thus its reach was markedly expanded. That the indigenous nonprofessional is capable of getting to, and bringing meaningful help to, the heretofore unreachable attests to the promise of this approach for densely populated ghettos with high disorder rates.

Programs cited in this section are significant beyond their own "tight little islands." As models they have generated significant ripple effects with important social consequences, including enactment of enabling legislation in areas such as economic opportunity and New Careers. Though these programs are hardly cut of the same cheesecloth, several of their common denominators bear mention. They focus far more on concrete behavior than on intrapsychic dynamics. Their settings, organizational structures, and modes of delivery are fashioned in full view of the needs and life styles of would-be helpees. Their goals, including institutional and community change, may often require social and political action. They engage problems of living directly in the natural ways in which such problems occur. They have effectively harnessed realistic, imaginative uses of nonprofessionals to open new programming directions.

CONCLUDING REMARKS

When widely accepted frameworks do not effectively handle problems within their mandated scope, and as new relevant problems are identified that they fail to address, it is time to reexamine assumptions and to consider alternatives. These are the critical elements that have precipitated the current SC ferment—a ferment of sufficient magnitude to warrant the designation "mental health's third revolution" (175). Cold evaluation of past dominant MH approaches invites the criticisms that, as articulated: they have not provided the manpower and resources needed to cope with evident problems and latent needs; they have not solved the baffling problems of major mental illness; their pivotal techniques have had, at best, limited effectiveness; and they either do not reach, or are inimical to, major segments of the population urgently requiring help. To those chronic concerns we must now add the new challenges posed by explosive social problems such as poverty and violence and their links to disorder, not seriously seen before as problems for the MH fields.

Notwithstanding the fact that its fine details remain fuzzy, the evolving SC framework offers a genuine alternative to prior dominant MH approaches. It is active rather than passive and accords far greater importance to prevention than to repair. Its key components include analysis and modification of social systems, including engineering environments and man-environment combinations, that maximize adaptation. Its person-oriented prongs stress such approaches as early childhood intervention, crisis intervention, and consultation which vastly extend reach and promise more nearly geometric payoff increments from finite resources. An SC approach turns us away from a fixed-entities view of disordered behavior and leaves open the possibility that many different, adverse "end states" can be averted by effective environmental engineering. As such, it focuses attention on the person-shaping attributes of communities and their primary social institutions and suggests that topics such as the schools or inner-city are at least as germane to the field of disordered behavior as traditional topical units such as paranoid schizophrenia or drug addiction.

The SC framework is in slow evolution. At this early stage two important concerns are its relative inattention to primary prevention, and its weak research base. Ultimately the latter will be crucial, lest we end up trading one set of "horse-faiths" for another. Presently this approach rests on a combination of logic and faith. While we are still far from being able to say that the SC mousetrap is a better one, we are sufficiently plagued by our own history and failings and by the omnipresent spectre of major, pressing, unresolved MH and social problems to recognize that this is a valid, if not urgent, direction for reflection, program development, and research.

LITERATURE CITED

1. Adelson, D., Kalis, B. L. 1970. *Community Psychology and Mental Health.* Scranton, Pa.: Chandler
2. Albee, G. W. 1959. *Mental Health Manpower Trends.* New York: Basic Books
3. Albee, G. W. 1967. The relation of conceptual models to manpower needs. See Ref. 86, 62–73
4. Albee, G. W. 1968. Models, myths and manpower. *Ment. Hyg.* 52:168–80
5. Albee, G. W. 1969. Emerging concepts of mental illness and models of treatment: the psychological point of view. *Am. J. Psychiat.* 125:42–48
6. Allinsmith, W., Goethals, G. W. 1962. *The Role of Schools in Mental Health.* New York: Basic Books
7. Andronico, M. P., Guerney, B. G. Jr. 1969. The potential application of filial therapy to the school situation. See Ref. 155, 371–77
8. Arnhoff, F. N. 1972. Manpower needs, resources, and innovations. See Ref. 23, 35–61
9. Arnhoff, F. N., Rubenstein, E. A., Speisman, J. C., Eds. 1969. *Manpower for Mental Health.* Chicago: Aldine
10. Ash, P. 1949. The reliability of psychiatric diagnosis. *J. Abnorm. Soc. Psychol.* 44:272–77
11. Banfield, E. C. 1968. *The Unheavenly City: The Nature and Future of Our Urban Crisis.* Boston: Little-Brown
12. Baratz, J. C. 1969. A bi-dialectical task for determining language proficiency in economically disadvantaged Negro children. *Child Develop.* 40:889–901
13. Bard, M. 1969. Family intervention police teams as a community mental health resource. *J. Crim. Law Criminol. Police Sci.* 60:247–50
14. Bard, M. 1970. *Training Police as Specialists in Family Crisis Intervention: Final Report.* Washington, D. C.: GPO
15. Bard, M. 1971. The role of law enforcement in the helping system. *Commun. Ment. Health J.* 7:151–60
16. Bard, M. 1971. The study and modification of intrafamilial violence. In *The Control of Aggression and Violence: Cognitive and Physiological,* ed. J. L. Singer, 149–64. New York: Academic
17. Bard, M., Berkowitz, B. 1967. Training police as specialists in family crisis interventions: a community psychology action program. *Commun. Ment. Health J.* 3:315–17
18. Bard, M., Berkowitz, B. 1969. A community psychology consultation program in police family crisis intervention: preliminary impressions. *Int. J. Soc. Psychiat.* 15:209–15
19. Barker, R. G. 1968. *Ecological Psychology.* Stanford Univ. Press
20. Barker, R. G. 1969. Wanted: an eco-behavioral science. See Ref. 360, 31–43
21. Barker, R. G., Gump, P. 1964. *Big School, Small School.* Stanford Univ. Press
22. Bellak, L., Ed. 1964. *Handbook of Community Psychiatry.* New York: Grune & Stratton
23. Bellak, L., Barten, H. H., Eds. 1969. *Progress in Community Mental Health, Vol. I.* New York: Grune & Stratton
24. Bennett, C. C. et al, Eds. 1966. *Community Psychology: A Report of the Boston Conference on the Education of Psychologists for Community Mental Health.* Boston Univ. Press
25. Bereiter, C. A. 1968. A nonpsychological approach to early compensatory education. See Ref. 98, 337–46
26. Bereiter, C. A., Englemann, S. 1966. *Teaching Disadvantaged Children in the Preschool.* Englewood Cliffs, N. J.: Prentice-Hall
27. Bergen, B. J., Thomas, C. S., Eds. 1966. *Issues and Problems in Social Psychiatry.* Springfield, Ill.: Thomas
28. Bergin, A. E. 1971. The evaluation of therapeutic outcomes. In *Handbook of Psychotherapy and Behavior Change: An Empirical Analysis,* ed. A. E. Bergin, S. L. Garfield, 217–70. New York: Wiley
29. Biber, B. 1961. Integration of mental health principles in the school setting. See Ref. 52, 378–97
30. Bindman, A. J., Spiegel, A. D., Eds. 1969. *Perspectives in Community Mental Health.* Chicago: Aldine
31. Birch, H. G. 1969. Health and the education of socially disadvantaged children. See Ref. 64, 265–91

32. Bloom, B. L. 1965. The "medical model," miasma theory, and community mental health. *Commun. Ment. Health J.* 1:33–38
33. Bloom, B. L. 1969. Training the psychologist for a role in community change. *Div. Commun. Psychol. Newsletter* 3:1–7
34. Bloom, B. L. 1971. Strategies for the prevention of mental disorders. See Ref. 310, 1–20
35. Bolman, W. G. 1968. Preventive psychiatry for the family: theory, approaches and programs. *Am. J. Psychiat.* 125:50–64
36. Bourne, R. S. 1970. *The Gary Schools.* Cambridge, Mass.: MIT
37. Bower, E. M. 1964. The modification, mediation and utilization of stress during the school years. *Am. J. Orthopsychiat.* 34:667–74
38. Bower, E. M. 1969. *Early Identification of Emotionally Handicapped Children in School.* Springfield: Thomas. 2nd ed.
39. Bower, E. M., Hollister, W. G., Eds. 1967. *Behavioral Science Frontiers in Education.* New York: Wiley
40. Bower, E. M., Shellhamer, T. A., Dailey, J. M. 1960. School characteristics of male adolescents who later became schizophrenic. *Am. J. Orthopsychiat.* 30:712–29
41. Bowman, G. W., Klopf, G. J. 1971. *New Careers and Roles in the American School.* New York: Bank St. Coll. Educ.
42. Braginsky, B. M., Braginsky, D. D., Ring, K. 1969. *Methods of Madness: The Mental Hospital as a Last Resort.* New York: Holt, Rinehart & Winston
43. Bredemeier, H. C. 1964. The socially handicapped and the agencies: a market analysis. See Ref. 298, 88–109
44. Brennan, E. C. 1967. College students and mental health programs for children. *Am. J. Public Health* 57:1767–71
45. Brill, N. Q., Storrow, H. A. 1964. Social class and psychiatric treatment. See Ref. 298, 68–75
46. Brockbank, R., Westby-Gibson, D., Eds. 1966. *Mental Health in a Changing Community.* New York: Grune & Stratton
47. Brown, B. B. et al 1969. *Systematic Observations Relating Theory and Practice in the Classroom.* Gainesville, Fla.: Inst. Develop. Hum. Res.
48. Brownbridge, R., Van Vleet, P., Eds. 1969. *Investments in Prevention: The Prevention of Learning and Behavior Problems in Young Children.* San Francisco: Pace I.D. Cent.
49. Cain, L. P., Epstein, D. W. 1967. The utilization of housewives as volunteer case aides. *Soc. Casework* 48: 282–86
50. Caldwell, B. M. 1968. The fourth dimension in early childhood education. See Ref. 173, 71–81
51. Campbell, A., Schuman, H. 1970. *Racial Attitudes in 15 American Cities.* Ann Arbor: Survey Res. Center
52. Caplan, G., Ed. 1961. *Prevention of Mental Disorders in Children: Initial Explorations.* New York: Basic Books
53. Caplan, G. 1961. *An Approach to Community Mental Health.* New York: Grune & Stratton
54. Caplan, G. 1964. *Principles of Preventive Psychiatry.* New York: Basic Books
55. Caplan, G. 1970. *Theories of Mental Health Consultation.* New York: Basic Books
56. Caplan, R. B. 1969. *Psychiatry and the Community in Nineteenth Century America.* New York: Basic Books
57. Carkhuff, R. R. 1968. Lay mental health counseling: prospects and problems. *J. Individ. Psychol.* 24: 88–93
58. Carkhuff, R. R. 1969. *Helping and Human Relations, Vol. I: Selection and Training.* New York: Holt, Rinehart & Winston
59. Carkhuff, R. R. 1969. *Helping and Human Relations, Vol. II: Practice and Research.* New York: Holt, Rinehart & Winston
60. Carkhuff, R. R., Truax, C. B. 1965. Training in counseling and psychotherapy: an evaluation of an integrated didactic and experimental approach. *J. Consult. Psychol.* 29: 333–36
61. Ibid. Lay mental health counseling: the effects of lay group counseling, 426–31
62. Carletti, J. A. 1964. Volunteers provide companionship therapy under social service supervision. *Ment. Hosp.* 15:691–93
63. Chesler, M., Fox, R. 1966. *Role Playing Methods in the Classroom.* Chicago: Sci. Res. Assoc.

64. Chess, S., Thomas, A., Eds. 1969. *Annual Progress in Child Psychiatry and Child Development.* New York: Brunner-Mazel
65. Chinsky, J. M., Rappaport, J. 1971. Evaluation of a technique for the behavioral assessment of nonprofessional mental health workers. *J. Clin. Psychol.* 27:400–2
66. Christmas, J. J. 1966. Group methods in training and practice: nonprofessional mental health personnel in a deprived community. *Am. J. Orthopsychiat.* 36:410–19
67. Clarizio, H. F., Ed. 1969. Stability of deviant behavior through time. In *Mental Health and the Educative Process*, 68–74. Chicago: Rand-McNally
68. Clark, K. B. 1967. Defeatism in ghetto schools. See Ref. 304, 599–610
69. Colbert, J., Hohn, M. 1971. *Guide to Manpower Training.* New York: Behavioral Publ.
70. Coleman, J. S., Ed. 1966. *Equality of Educational Opportunity.* Washington, D. C.: US Dep. HEW
71. Coleman, J.S. 1971. *Resources for Social Change.* New York: Wiley
72. Connery, R. H., Ed. 1968. *The Politics of Mental Health.* New York: Columbia Univ.
73. Cook, P. E., Ed. 1970. *Community Psychology and Community Mental Health.* San Francisco: Holden-Day
74. Cooper, M. 1967. The parents exchange on problems of youth. *Commun. Ment. Health J.* 3:355–57
75. Cooper, M., Southard, C. G. 1966. The mental health exchange: an important function of a community mental health center. *Commun. Ment. Health J.* 2:343–46
76. Cowen, E. L. 1967. Emergent approaches to mental health problems: an overview and directions for future work. See Ref. 86, 389–455
77. Cowen, E. L. 1968. The effectiveness of secondary prevention programs using nonprofessionals in the school setting. *Proc. 76th Ann. Conv. APA* 2:705–6
78. Cowen, E. L. 1969. Mothers in the classroom. *Psychol. Today* 2:36–39
79. Cowen, E. L. 1971. Coping with school adaptation problems. *Psychol. Schools* 8:322–29
80. Cowen, E. L. 1971. Emergent directions in school mental health. *Am. Sci.* 59:723–33
81. Cowen, E. L., Carlisle, R. L., Kaufman, G. 1969. Evaluation of a college student volunteer program with primary graders experiencing school adjustment problems. *Psychol. Schools* 6:371–75
82. Cowen, E. L., Chinsky, J. M., Rappaport, J. 1970. An undergraduate practicum in community mental health. *Commun. Ment. Health J.* 6:91–100
83. Cowen, E. L., Dorr, D., Izzo, L. D., Madonia, A., Trost, M. A. 1971. The Primary Mental Health Project: a new way to conceptualize and deliver shool mental health service. *Psychol. Schools* 8:216–25
84. Cowen, E. L., Dorr, D. A., Orgel, A. R. 1971. Interrelations among screening measures for early detection of school dysfunction. *Psychol. Schools* 8:135–39
85. Cowen, E. L., Dorr, D., Trost, M. A., Izzo, L. D. 1972. A follow-up study of maladapting school children seen by nonprofessionals. *J. Consult. Clin. Psychol.* 36:235–38
86. Cowen, E. L., Gardner, E. A., Zax, M., Eds. 1967. *Emergent Approaches to Mental Health Problems.* New York: Appleton-Century-Crofts
87. Cowen, E. L., Leibowitz, E., Leibowitz, G. 1968. The utilization of retired people as mental health aides in the schools. *Am. J. Orthopsychiat.* 38:900–9
88. Cowen, E. L., Trost, M. A., Izzo, L. D. 1973. Nonprofessional human service personnel in consulting roles. *Commun. Ment. Health J.* 9. In press
89. Cowen, E. L., Zax, M. 1969. Early detection and prevention of emotional disorder: conceptualizations and programming. In *Research Contributions from Psychology to Community Mental Health*, ed. J. W. Carter, 46–59. New York: Behavioral Publ.
90. Cowen, E. L., Zax, M., Izzo, L. D., Trost, M. A. 1966. Prevention of emotional disorders in the school setting: a further investigation. *J. Consult. Psychol.* 30:381–87
91. Cowen, E. L., Zax, M., Laird, J. D. 1966. A college student volunteer program in the elementary school

setting. *Commun. Ment. Health J.* 2:319–28

92. Cumming, E. 1968. *Systems of Social Regulation.* New York: Atherton
93. Cumming, J., Cumming, E. 1966. *Ego and Milieu: Theory and Practice of Environmental Therapy.* New York: Atherton
94. Daley, C. U., Ed. 1969. *Urban Violence.* Univ. Chicago Press
95. Davison, G. C. 1965. The training of undergraduates as social reinforcers for autistic children. In *Case Studies in Behavior Modification*, ed. L. P. Ullman, L. Krasner, 146–48. New York: Holt, Rinehart & Winston
96. Deutsch, C. P., Deutsch, M. 1968. Brief reflections on the theory of early childhood enrichment programs. See Ref. 173, 83–90
97. Deutsch, M., Ed. 1967. *The Disadvantaged Child: Studies of the Social Environment and the Learning Process.* New York: Basic Books
98. Deutsch, M., Katz, I., Jensen, A. R., Eds. 1968. *Social Class, Race, and Psychological Development.* New York: Holt, Rinehart & Winston
99. Dielman, T. E., Cattell, R. B., Lepper, C. 1971. Dimensions of problem behavior in the early grades. *J. Consult. Clin. Psychol.* 37:243–49
100. Dohrenwend, B. P., Dohrenwend, B. S. 1969. *Social Status and Psychological Disorder.* New York: Wiley
101. Donahue, G. T. 1967. A school district program for schizophrenic, organic, and seriously disturbed children. See Ref. 86, 369–86
102. Donahue, G. T., Nichtern, S. 1965. *Teaching the Troubled Child.* New York: Free Press
103. Dubos, R. 1965. *Man Adapting.* New Haven: Yale Press
104. Duhl, L. J., Leopold, R. L., Eds. 1968. *Mental Health and Urban Social Policy.* San Francisco: Jossey-Bass
105. Dumont, M. 1968. *The Absurd Healer: Perspectives of a Community Psychiatrist.* New York: Science House
106. Dunham, H. W. 1965. Community psychiatry: the newest therapeutic bandwagon. *Arch. Gen. Psychiat.* 12:303–13
107. Eicker, W. F. 1967. *The Application of Systems Technology to Community Mental Health.* Decatur, Ill.: Adolph Meyer Zone Center
108. Erikson, E. H. 1959. *Identity and the Life Cycle.* New York: Int. Univ. Press. *Psychol. Issues Monogr.* 1
109. Ewalt, P. L., Ed. 1967. *Mental Health Volunteers.* Springfield: Thomas
110. Eysenck, H. J. 1952. The effects of psychotherapy: an evaluation. *J. Consult. Psychol.* 16:319–24
111. Eysenck, H. J., Ed. 1961. The effects of psychotherapy. In *Handbook of Abnormal Psychology*, 697–725. New York: Basic Books
112. Eysenck, H. J. 1965. The effects of psychotherapy. *Int. J. Psychiat.* 1: 97–178
113. Eysenck, H. J. 1966. *The Effects of Psychotherapy.* New York: Int. Sci. Press
114. Fairweather, G. 1967. *Methods for Experimental Social Innovation.* New York: Wiley
115. Faust, V. 1968. *The Counselor-Consultant in the Elementary School.* New York: Houghton-Mifflin
116. Faust, V. 1968. *Establishing Guidance Programs in Elementary Schools.* New York: Houghton-Mifflin
117. Feldhusen, J. F., Thurston, J. R., Benning, J. J. 1969. Aggressive classroom behavior and school achievement. *J. Spec. Educ.* 4: 431–39
118. Feldhusen, J. F., Thurston, J. R., Benning, J. J. 1970. Longitudinal analysis of classroom behavior and school achievement. *J. Exp. Educ.* 38:4–10
119. Feldman, M. J., Ed. 1971. *Studies in Psychotherapy and Behavior Change, No. 2: Theory and Research in Community Mental Health.* Buffalo, N. Y.: SUNYAB
120. Fellows, L., Wolpin, M. 1966. High school trainees in a mental hospital. In *The Use of Nonprofessional and Preprofessional Personnel as a Partial Solution to the Manpower Shortage*, 1–5. Camarillo, Calif.: Camarillo State Hosp.
121. Fidler, J. W., Guerney, B. G. Jr., Andronico, M. P., Guerney, L. 1969. Filial therapy as a logical extension of current trends in psychotherapy. See Ref. 155, 47–56
122. Finney, J. C., Ed. 1969. *Culture Change, Mental Health and Poverty.* Lexington: Univ. Kentucky
123. Fishman, J. R. et al 1965. *Training for New Careers.* Washington, D. C.: Howard Univ.
124. Fishman, J. R., Denham, W. H., Levine, M., Shatz, E. O. 1969. *New*

Careers for the Disadvantaged in Human Service: Report of a Social Experiment. Washington, D. C.: Howard Univ. Inst. Youth Stud.

125. Fox, R., Luszki, M. B., Schmuck, R. 1966. *Diagnosing Classroom Learning Environments*. Chicago: Sci. Res. Assoc.
126. Frost, J. L., Hawkes, C. R., Eds. 1970. *The Disadvantaged Child: Issues and Innovations*. Boston: Houghton-Mifflin
127. Fullmer, D. W., Bernard, H. W. 1972. *The School Counselor-Consultant*. Boston: Houghton-Mifflin
128. Gannon, T. M. 1968. The role of the nonprofessional in the Harlem domestic peace corps. *Sociol. Soc. Res*. 52:348–62
129. Gardner, E. A. 1967. Psychological care for the poor: the need for new service patterns with a proposal for meeting this need. See Ref. 86, 185–214
130. Gartner, A. 1971. *Paraprofessionals and Their Performance*. New York: Praeger
131. Gartner, A., Kohler, M. C., Riessman, F. 1971. *Children Teach Children*. New York: Harper & Row
132. Gildea, M. C. L. 1959. *Community Mental Health*. Springfield: Thomas
133. Gildea, M. C. L., Glidewell, J. C., Kantor, M. B. 1967. The St. Louis school mental health project: history and evaluation. See Ref. 86, 290–306
134. Glidewell, J. C. 1966. Perspectives in community mental health. See Ref. 24, 33–49
135. Glidewell, J. C. 1971. System linkage and distress at school. See Ref. 119, 27–44
136. Glidewell, J. C. 1971. Priorities for psychologists in community mental health. See Ref. 310, 141–53
137. Glidewell, J. C., Swallow, C. S. 1969. *The Prevalence of Maladjustment in Elementary Schools*. Univ. Chicago
138. Golann, S. E., Ed. 1969. *Coordinate Index Reference Guide to Community Mental Health*. New York: Behavioral Publ.
139. Goldberg, G. S. 1969. Nonprofessionals in human services. See Ref. 152, 12–39
140. Goldenberg, I. I. 1968. The Residential Youth Center: the creation of an assumptions-questioning rehabilitative setting. In *Criminal Corrections in Connecticut: Perspectives and Progress*, 40–59. West Hartford Conn. Plan. Comm. Crim. Admin.
141. Goldenberg, I. I. 1971. The Residential Youth Center: Problems of theory and research in the creation of a community based rehabilitative setting. See Ref. 119, 67–92
142. Goldenberg, I. I. 1971. *Build Me a Mountain: Youth, Poverty and the Creation of New Settings*. Cambridge, Mass.: MIT Press
143. Goodman, G. 1967. An experiment with companionship therapy: college students and troubled boys—assumptions, selection, and design. *Am. J. Public Health* 57:1772–77
144. Goodman, G. 1972. Systematic selection of therapeutic talent: the group assessment of interpersonal traits. In *Handbook of Community Mental Health*, ed. S. E. Golann, C. Eisdorfer, 939–54. New York: Appleton-Century-Crofts. In press
145. Goodman, G. 1972. *Companionship Therapy: Studies of Structured Intimacy*. San Francisco: Jossey-Bass
146. Gordon, I. 1969. *Early Child Stimulation Through Parent Education*. Gainesville, Fla.: Inst. Develop. Hum. Res.
147. Gorlich, E. H. 1967. Volunteers in institutions for delinquents. *Children* 14:147–50
148. Gray, S. W., Klaus, R. 1965. An experimental pre-school program for culturally deprived children. *Child Develop*. 36:887–98
149. Gray, S. W., Klaus, R. 1968. The early training project and its general rationale. See Ref. 173, 63–70
150. Greenhill, H. I., Brown, C. A. 1969. *Allied Health Manpower: Trends and Prospects*. New York: Columbia
151. Griffith, C. R., Libo, L. M. 1968. *Mental Health Consultants: Agents of Community Change*. San Francisco: Jossey-Bass
152. Grosser, C., Henry, W. E., Kelly, J. G., Eds. 1969. *Nonprofessionals in the Human Services*. San Francisco: Jossey-Bass
153. Grunebaum, H., Ed. 1970. *The Practice of Community Mental Health*. Boston: Little-Brown
154. Gruver, G. G. 1971. College students as therapeutic agents. *Psychol. Bull*. 76:111–27
155. Guerney, B. G. Jr., Ed. 1969. *Psychotherapeutic Agents: New Roles for Nonprofessionals, Parents and*

Teachers. New York: Holt, Rinehart & Winston

156. Ibid. Filial therapy: description and rationale, 450–61
157. Gump, P. V. 1969. Intro-setting analysis: the third grade classroom as a special but instructive case. See Ref. 360, 200–20
158. Gurin, G. 1968. *Inner City Negro Youth in a Job-Training Project.* Ann Arbor, Mich.: Survey Res. Cent.
159. Gurin, G., Veroff, J., Feld, S. 1960. *Americans View their Mental Health: A Nationwide Survey.* New York: Basic Books
160. Haase, W. 1964. The role of socioeconomic class and examiner class in examiner bias. See Ref. 298, 241–47
161. Hallowitz, E., Riessman, F. 1967. The role of the indigenous nonprofessional in a community mental health neighborhood services center program. *Am. J. Orthopsychiat.* 37:766–78
162. Halpern, W. I. 1969. The community mental health aide. *Ment. Hyg.* 53:78–83
163. Harrington, M. 1962. *The Other America: Poverty in the United States.* Baltimore: Penguin
164. Harris, J. G., Ed. 1966. *Mental Health Manpower Needs in Psychology.* Lexington: Univ. Kentucky
165. Hartog, J. 1967. Nonprofessionals as mental health consultants. *Hosp. Commun. Psychiat.* 18:223–25
166. Hauser, S. T. 1971. *Black and White Identity Formation.* New York: Wiley
167. Hawkins, R. P., Peterson, E. S., Bijou, S. W. 1969. Behavior therapy in the home: amelioration of problem parent-child relations with the parent in a therapeutic role. See Ref. 155, 392–401
168. Heilig, S. M., Farberow, N. L., Litman, R. E., Schneideman, E. S. 1968. The role of nonprofessional volunteers in a suicide prevention center. *Commun. Ment. Health J.* 4:287–95
169. Hellmuth, J., Ed. 1969. *Disadvantaged Child, Vol. 1.* New York: Brunner-Mazel
170. Hellmuth, J., Ed. 1969. *Disadvantaged Child, Vol. 2.* New York: Brunner-Mazel
171. Hellmuth, J., Ed. 1970. *Disadvantaged Child, Vol. 3.* New York: Brunner-Mazel
172. Hereford, C. F. 1963. *Changing Parental Attitudes Through Group Discussion.* Austin: Univ. Texas
173. Hess, R. D., Bear, R. M., Eds. 1968. *Early Education.* Chicago: Aldine
174. Hewett, F. M. 1968. *The Emotionally Disturbed Child in the Classroom.* Boston: Allyn-Bacon
175. Hobbs, N. 1964. Mental health's third revolution. *Am. J. Orthopsychiat.* 34:822–33
176. Hobbs, N. 1966. Helping disturbed children: psychological and ecological strategies. *Am. Psychol.* 21:1105–15
177. Hobbs, N. 1967. The reeducation of emotionally disturbed children. See Ref. 39, 339–54
178. Hobbs, N. 1969. Reeducation, reality, and community responsibility. See Ref. 89, 7–18
179. Holand, M. W., Voss, F. H. 1968. Nontraditional assignments for volunteers. *Hosp. Commun. Psychiat.* 19, 221
180. Hollingshead, B. B., Redlich, F. C. 1958. *Social Class and Mental Illness: A Community Study.* New York: Wiley
181. Hollister, W. G. 1965. The concept of "strens" in preventive intervention and ego strength building in the schools. In *The Protection and Promotion of Mental Health in Schools*, ed. N. M. Lambert, 30–35. Bethesda, Md.: US Dep. HEW PHS Publ. 1226
182. Hollister, W. G. 1967. Concept of strens in education: a challenge to curriculum development. See Ref. 39, 193–205
183. Holtzman, W. H., Sells, S. B. 1954. Prediction of flying success by clinical analysis of test protocols. *J. Abnorm. Soc. Psychol.* 49:485–98
184. Holzberg, J. D. 1963. The companion program: implementing the manpower recommendations of the Joint Commission on Mental Illness and Health. *Am. Psychol.* 18: 224-26
185. Holzberg, J. D., Knapp, R. H., Turner, J. L. 1967. College students as companions to the mentally ill. See Ref. 86, 91–109
186. Hornstein, H. A., Bunker, B. B., Burke, W. W., Gindes, M., Lewicki, R. J., Eds. 1971. *Social Intervention: A Behavioral Science Approach.* New York: Free Press
187. Horowitz, F. D., Paden, L. Y. The effectiveness of environmental intervention programs. In *Review of*

Child Development Research, Vol. 3, ed. B. M. Caldwell, H. Ricciuti. In press

188. Huessy, H. R., Ed. 1966. *Mental Health with Limited Resources: Yankee Ingenuity in Low-Cost Programs.* New York: Grune & Stratton
189. Hunt, J. McV. 1969. Message, potpourri and the Hall-Nebraska model. *Clin. Psychol.* 22:127–36
190. Hunt, J. McV. 1969. *The Challenge of Incompetence and Poverty.* Champaign: Univ. Illinois Press
191. Hurley, R. 1969. *Poverty and Mental Health: A Causal Relationship.* New York: Random House
192. Iscoe, I. 1971. Professional and subprofessional training in community mental health as an aspect of community psychology. See Ref. 310, 21–32
193. Iscoe, I., Spielberger, C. D., Eds. 1970. *Community Psychology: Perspectives in Training and Research.* New York: Appleton-Century-Crofts
194. Jellinek, E. 1939. Some principles of psychiatric classification. *Psychiatry* 2:161–65
195. Jensen, A. R. 1969. How much can we boost I.Q. and scholastic achievement? *Harvard Educ. Rev.* 39:1–123
196. Johnston, R. 1967. Some casework aspects of using foster grandparents for emotionally disturbed children. *Children* 14:46–52
197. Joint Commission on Mental Illness 1961. *Action for Mental Health.* New York: Basic Books
198. Joint Commission on Mental Health of Children 1970. *Crisis in Child Mental Health: Challenge for the 1970's.* New York: Harper & Row
199. Kanfer, F. H., Saslow, G. 1965. Behavioral analyses. *Arch. Gen. Psychiat.* 12:529–38
200. Kantor, D., Greenblatt, M. 1962. Wellmet: halfway to community rehabilitation. *Ment. Hosp.* 13: 146–52
201. Kaplan, B. H. 1971. *Psychiatric Disorder and the Urban Environment.* New York: Behavioral Publ.
202. Kaplan, D. M. 1968. Observations on crisis theory and practice. *Soc. Casework* 49:151–55
203. Kaplan, L. 1971. *Education and Mental Health.* New York: Harper & Row
204. Katkin, S., Ginsburg, M., Rifkin, M. J., Scott, J. T. 1971. Effectiveness of female volunteers in the treatment of outpatients. *J. Couns. Psychol.* 18:97–100
205. Katz, I., Gurin, G., Eds. 1969. *Race and the Social Sciences.* New York: Basic Books
206. Kellam, S. G., Schiff, S. K. 1967. Adaptation and mental illness in the first grade classrooms of an urban community. *APA Psychiat. Res. Rep.* 21:79–91
207. Kelley, E. L., Fiske, D. W. 1951. *The Prediction of Performance in Clinical Psychology.* Ann Arbor: Univ. Michigan
208. Kelly, J. G. 1964. The mental health agent in the urban community. In *Urban America and the Planning of Mental Health Services*, 474–94. New York: Group for Advancement of Psychiatry
209. Kelly, J. G. 1966. Ecological constraints on mental health services. *Am. Psychol.* 21:535–39
210. Kelly, J. G. 1968. Towards an ecological conception of preventive intervention. See Ref. 89, 75–97
211. Kelly, J. G. 1969. Naturalistic observations in contrasting social environments. See Ref. 360, 183–99
212. Kelly, J. G. 1970. The quest for valid preventive interventions. In *Current Topics in Clinical and Community Psychology*, ed. C. D. Spielberger, 2:183–207. New York: Academic
213. Kelly, J. G. 1971. Qualities for the community psychologist. *Am. Psychol.* 26:897–903
214. Kelly, J. G. et al 1971. The coping process in varied high school environments. See Ref. 119, 95–166
215. Kiesler, F. 1969. More than psychiatry: a rural program. See Ref. 329, 103–20
216. Kiev, A. 1969. *Social Psychiatry, Vol. 1.* New York: Science House
217. Klein, D. C. 1968. *Community Dynamics and Mental Health.* New York: Wiley
218. Klein, W. L. 1967. The training of human service aides. See Ref. 86, 144–61
219. Kosa, J., Antonovsky, A., Zola, I. K., Eds. 1969. *Poverty and Health: A Sociological Analysis.* Cambridge, Mass.: Harvard Univ.
220. Kreitzer, S. F. 1969. College students in a behavior therapy program with hospitalized emotionally disturbed children. See Ref. 155, 226–30
221. Lamb, H. R., Heath, D., Downing,

J. J., Eds. 1969. *Handbook of Community Mental Health Practice.* San Francisco: Jossey-Bass

222. Lawrence, M. M. 1971. *The Mental Health Team in the Schools.* New York: Behavioral Publ.
223. Leighton, A. H. 1960. *An Introduction to Social Psychiatry.* Springfield: Thomas
224. Leighton, D. C. 1956. Distribution of psychiatric symptoms in a small town. *Am. J. Psychiat.* 112:716–23
225. Lemkau, P. V. 1969. The planning project for Columbia. See Ref. 329, 193–204
226. Lennard, H. L., Bernstein, A. 1969. *Patterns in Human Interaction.* San Francisco: Jossey-Bass
227. Levine, M., Graziano, A. M. 1972. Intervention programs in elementary schools. See Ref. 144, 541–73
228. Levine, M., Levine, A. 1970. *A Social History of Helping Services.* New York: Appleton-Century-Crofts
229. Levine, M., Levine, A. 1971. An historical study of the settlement house movement: a model for community psychology programs. See Ref. 119, 3–23
230. Levine, S., Scotch, N. A., Eds. 1970. *Social Stress.* Chicago: Aldine
231. Levitt, E. E. 1957. The results of psychotherapy with children: An evaluation. *J. Consult. Psychol.* 21:189–96
232. Levitt, E. E. 1963. Psychotherapy with children: a further evaluation. *Behav. Res. Ther.* 35:500–8
233. Levitt, E. E. 1971. Research on psychotherapy with children. See Ref. 28, 474–94
234. Lewis, W. W. 1967. Project Re-Ed: educational intervention in discordant child rearing systems. See Ref. 86, 352–68
235. Lindemann, E. 1944. Symptomatology and management of acute grief. *Am. J. Psychiat.* 101:141–48
236. Linden, J. I., Stollak, G. E. 1969. The training of undergraduates in play techniques. *J. Clin. Psychol.* 25:213–78
237. Linder, R. 1965. Diagnosis: description or prescription? A case study of the psychology of diagnosis. *Percept. Mot. Skills* 20:1081–92
238. Little, K. B., Schneideman, E. S. 1959. Congruencies among interpretations of psychological and anamnestic data. *Psychol. Monogr.* 73, No. 6, Whole No. 476
239. Long, B. E. 1968. Teaching psychology to children. *Am. Psychol.* 23: 691–92
240. Lorion, R. P. 1973. Socioeconomic status and traditional treatment approaches reconsidered. *Psychol. Bull.* 80. In press
241. Lynch, M., Gardner, E. A., Felzer, S. B. 1968. The role of indigenous personnel as clinical therapists. *Arch. Gen. Psychiat.* 19:428–34
242. MacLennan, B. W. 1969. New careers: program development and the process of institutional change. See Ref. 329, 179–90
243. MacLennan, B. W., Klein, W. L., Pearl, A., Fishman, J. R. 1966. Training for new careers. *Commun. Ment. Health J.* 2:135–41
244. MacLennan, B. W., Quinn, R. D., Schroeder, D. 1971. *The Scope of Community Mental Health Consultation and Education.* Washington, D. C.: NIMH, PHS Publ. 2169
245. Magoon, T. M., Golann, S. E., Freeman, R. W. 1969. *Mental Health Counselors at Work.* New York: Pergamon
246. Mannino, F. V. 1969. *Consultation in Mental Health and Related Fields: A Reference Guide.* Washington, D. C.: NIMH, PHS Publ. 1920
247. Masserman, J., Carmichael, H. 1938. Diagnosis and prognosis in psychiatry. *J. Ment. Sci.* 84:893–946
248. McClung, F. B., Stunden, A. A. 1970. *Mental Health Consultation to Programs for Children: A Review of Data Collected from Selected U. S. Sites.* Washington, D. C.: NIMH, PHS Publ. 2066
249. McGee, T. F. 1968. Some basic considerations in crisis intervention. *Commun. Ment. Health J.* 4:319–25
250. McWilliams, S. A., Finkel, N. J. High school students as mental health aides in the elementary setting. *J. Consult. Clin. Psychol.* 36. In press
251. Meehl, P. E. 1959. Some ruminations on the validation of clinical procedures. *Can. J. Psychol.* 13:102–28
252. Mehlman, B. 1952. The reliability of psychiatric diagnosis. *J. Abnorm. Soc. Psychol.* 47:577–78
253. Michael, D. N. 1968. *The Unprepared Society: Planning for a Precarious Future.* New York: Basic Books
254. Michael, D. N., Ed. 1970. *The Future Society.* Chicago: Aldine
255. Miller, H. L., Woock, R. R. 1970.

Social Foundations of Urban Education. Hinsdale, Ill.: Dryden

256. Miller, L. 1967. Louisville Behavior Check List for males 6–12 years of age. *Psychol. Rep.* 21:885–96
257. Miller, L. 1972. School Behavior Check List: an inventory of deviant behavior for elementary school children. *J. Consult. Clin. Psychol.* 38:134–44
258. Miller, S. M., Riessman, F. 1968. *Social Class and Social Policy*. New York: Basic Books
259. Minuchin, P., Biber, B., Shapiro, E., Zimiles, H. 1969. *The Psychological Impact of School Experience*. New York: Basic Books
260. Mitchell, W. E. 1966. Amicatherapy: theoretical perspectives and an example of practice. *Commun. Ment. Health J.* 2:307–14
261. Mitchell, W. E. 1966. The use of college students in the outpatient treatment of troubled children. See Ref. 188, 28–37
262. Monroe, R. R., Klee, G. D., Brody, E. B. 1967. *Psychiatric Epidemiology and Mental Health Planning*. Washington, D. C.: Am. Psychiat. Assoc.
263. Myers, J. K., Bean, L. L. 1968. *A Decade Later: A Follow-up of Social Class and Mental Illness*. New York: Wiley
264. Nathan, P. E., Andberg, M. M., Behan, P. O., Patch, V. D. 1969. Thirty-two observers and one patient: a study of diagnostic reality. *J. Clin. Psychol.* 25:9–15
265. Neale, D. C., Mussell, B. 1968. Effects of big brother relationships on the school-related attitudes of disadvantaged children. *J. Spec. Educ.* 2:397–404
266. Newfield, N. L. 1971. *An evaluation of mental health consultation for public health nurses*. PhD thesis. Univ. Rochester
267. Newman, P. R. 1972. Socialization in varied high school environments. In *The Ecological Perspective: Research and Reforms for the High School Environment*, ed. D. Adelson. New York: Behavioral Publ.
268. Newman, R. G. 1967. *Psychological Consultation in the Schools*. New York: Basic Books
269. Newton, M. R., Brown, R. D. 1967. A preventive approach to developmental problems in school children. See Ref. 39, 503–27
270. Nichtern, S. et al 1964. A community educational program for the emotionally disturbed child. *Am. J. Orthopsychiat.* 34:705–13
271. NIMH Ad Hoc Committee on Child Mental Health 1971. *Report to the Director*. Washington,. D. C.: US Dep. HEW
272. Nunn, D., Ed. 1971. *NEWCOM: Summary*. Louisville, Ky.: Urban Studies Center
273. Nunn, D., Ed. 1971. *NEWCOM: The Enabling Elements*. Louisville, Ky.: Urban Studies Center
274. Odum, H. T. 1971. *Environment, Power, and Society*. New York: Wiley
275. Ojemann, R. H. 1969. Incorporating psychological concepts in the school curriculum. See Ref. 67, 360–68
276. O'Neal, P., Robins, L. N. 1958. The relation of childhood behavior problems to adult psychiatric status: a 30 year follow-up of 150 subjects. *Am. J. Psychiat.* 114:961–69
277. O'Neal, P., Robins, L. N. 1958. Childhood patterns predictive of adult schizophrenia: a 30 year follow-up. *Am. J. Psychiat.* 115: 385–91
278. Onondaga County School Studies, Int. Rep. No. 1, 1964. *Persistence of Emotional Disturbances Reported Among Second and Fourth Grade Children*. Syracuse: N.Y.S. Dep. Ment. Hyg., Ment. Health Res. Unit
279. Painter, G. 1969. The effect of a structured tutorial program on cognitive and language development of a culturally disadvantaged group. *Merrill-Palmer Quart.* 15: 279–94
280. Paul, G. L. 1969. Chronic mental patients: current status-future direction. *Psychol. Bull.* 71:81–94
281. Pavenstedt, E., Bernard, V. W., Eds. 1971. *Crises of Family Disorganization*. New York: Behavioral Publ.
282. Pearl, A., Riessman, F. 1965. *New Careers for the Poor*. New York: Free Press
283. Peck, H. B., Kaplan, S. R. 1969. A mental health program for the urban multi-service center. See Ref. 329, 123–42
284. Perlmutter, F., Durham, D. 1965. Using teenagers to supplement casework service. *Soc. Work* 10: 41–48
285. Petroni, F. A., Hirsch, E. A., Petroni, C. L. 1970. *2, 4, 6, 8, When*

You Gonna Integrate? New York: Behavioral Publ.

286. Pimm, J. B., McClure, G. 1968. *Ottawa School Behavior Check List.* Ottawa, Can.: Pimm Consultants
287. Poser, E. G. 1966. The effect of therapist training on group therapeutic outcome. *J. Consult. Psychol.* 30:283–89
288. Query, W. T. 1968. *Illness, Work and Poverty.* San Francisco: Jossey-Bass
289. Rae-Grant, Q., Stringer, L. A. 1969. Mental health programs in schools. See Ref. 329, 83–99
290. Rappaport, J., Chinsky, J. M., Cowen, E. L. 1971. *Innovations in Helping Chronic Patients: College Students in a Mental Hospital.* New York: Academic
291. Rees, H. E. 1968. *Deprivation and Compensatory Education.* New York: Houghton-Mifflin
292. Reiff, R. 1967. Mental health manpower and institutional change. See Ref. 86, 74–88
293. Reiff, R. 1971. Community psychology and public policy. See Ref. 310, 33–54
294. Reiff, R., Riessman, F. 1965. The indigenous nonprofessional. *Commun. Ment. Health J. Monogr. 1*
295. Reinherz, H. 1963. College student volunteers as case-aides in a state hospital for children. *Am. J. Orthopsychiat.* 33:544–46
296. Riessman, F. 1965. The "helper"-therapy principle. *Soc. Work* 10: 27–32
297. Riessman, F. 1967. A neighborhood based mental health approach. See Ref. 86, 167–84
298. Riessman, F., Cohen, J., Pearl, A., Eds. 1964. *Mental Health of the Poor.* New York: Free Press
299. Riessman, F., Popper, H. I., Eds. 1968. *Up from Poverty.* New York: Harper & Row
300. Rioch, M. J. 1966. Changing concepts in the training of therapists. *J. Consult. Psychol.* 30:290–92
301. Rioch, M. J. 1967. Pilot projects in training mental health counselors. See Ref. 86, 110–27
302. Rioch, M. J., Elkes, C., Flint, A. A. 1965. *NIMH Pilot Project in Training Mental Health Counselors.* US Dept. HEW PHS Serv. Publ. 1254
303. Rioch, M. J. et al 1963. NIMH pilot study in training of mental health counselors. *Am. J. Orthopsychiat.* 33:678–89
304. Roberts, J. I., Ed. 1967. *School Children in the Urban Slum.* New York: Free Press
305. Roberts, L. M., Halleck, S. L., Loeb, M. B., Eds. 1966. *Community Psychiatry.* Madison: Univ. Wisconsin
306. Robins, L. N. 1966. *Deviant Children Grown Up.* Baltimore: Williams & Wilkins
307. Roen, S. R. 1967. Primary prevention in the classroom through a teaching program in the behavioral sciences. See Ref. 86, 252–70
308. Roen, S. R. 1971. Evaluative research and community mental health. See Ref. 28, 776–811
309. Rosenbaum, M. 1966. Some comments on the use of untrained therapists. *J. Consult. Psychol.* 30:292–94
310. Rosenblum, G., Ed. 1971. *Issues in Community Psychology and Preventive Mental Health.* New York: Behavioral Publ.
311. Rubin, E. Z. 1970. A psycho-educational model for school mental health planning. *Commun. Ment. Health J.* 6:31–39
312. Rubin, E. Z., Simson, C. B., Betwee, M. C. 1966. *Emotionally Handicapped Children and the Elementary School.* Detroit: Wayne Univ.
313. Ryan, W., Ed. 1969. *Distress in the City.* Cleveland: Case-Western Univ.
314. Sanford, N. 1965. The prevention of mental illness. In *Handbook of Clinical Psychology,* ed. B. Wolman, 1378–1400. New York: McGraw-Hill
315. Sanua, V. D. 1966. Sociocultural aspects of psychotherapy and treatment: a review of the literature. In *Progress in Clinical Psychology, Vol. VIII,* ed. L. E. Abt, L. Bellak, 256–310. New York: Grune & Stratton
316. Sarason, I. G., Ganzer, V. J. 1969. Social influence techniques in clinical and community psychology. See Ref. 212, 1:1–66
317. Sarason, S. B. 1971. The creation of settings. See Ref. 119, 47–63

317a. Sarason, S. B. 1971. *The Culture of the School and the Problem of Change.* Boston: Allyn-Bacon

318. Sarason, S. B., Levine, M., Goldenberg, I. I., Cherlin, D. L., Bennett, E. M. 1966. *Psychology in Com-*

munity Settings. New York: Wiley

319. Sarason, S. B., Zitnay, G., Grossman, F. K. 1971. *The Creation of a Community Setting*. Syracuse Univ. Press
320. Schaefer, E. S. 1968. Intellectual stimulation of culturally deprived infants. Unpublished ms
321. Schaefer, E. S., Aaronson, M. Infant Education Research Project: implementation and implications for a home tutoring project. In *Conceptualization of Preschool Curricula*, ed. R. Parker. In press
322. Scheff, T. J. 1966. *Being Mentally Ill: A Sociological Theory*. Chicago: Aldine
323. Scheibe, K. E. 1965. College students spend eight weeks in mental hospital: a case report. *Psychother. Theory, Res., Pract.* 2:117–20
324. Schmuck, R., Chesler, M., Lippitt, R. 1966. *Problem Solving to Improve Classroom Learning*. Chicago: Sci. Res. Assoc.
325. Schwab, J. J. 1968. *Handbook of Psychiatric Consultation*. New York: Appleton-Century-Crofts
326. Severson, R. A. 1971. *The rationale and development of teacher completed behavior rating scales*. Presented at Nat. Counc. Meas. Educ., New York
327. Shah, S. A. 1969. Training and utilizing a mother as the therapist for her child. See Ref. 155, 401–8
328. Shapiro, D. S., Maholick, L. T., Brewer, E. D. C., Robertson, R. N. 1968. *The Mental Health Counselor in the Community*. Springfield: Thomas
329. Shore, M. F., Mannino, F. V., Eds. 1969. *Mental Health and the Community: Problems, Programs and Strategies*. New York: Behavioral Publ.
330. Signell, K. A. 1972. Kindergarten entry: a preventive approach to community mental health. *Commun. Ment. Health J.* 8:60–70
331. Smith, D. C., Stoffer, D. L. 1968. *The Community Helper Program in the Schools: Guidelines for Organization and Administration*. Columbus, Ohio: O.S.U. Res. Found.
332. Smith, H. C. 1966. *Sensitivity to People*. New York: McGraw-Hill
333. Smith, M. B., Hobbs, N. 1966. The community and community mental health center. *Am. Psychol.* 21:499–509
334. Sobey, F. 1970. *The Nonprofessional Revolution in Mental Health*. New York: Columbia Univ.
335. Specter, G. A., Cowen, E. L. 1971. A pilot study in stimulation of culturally deprived infants. *Child Psychiat. Hum. Develop.* 1:168–77
336. Spielberger, C. D. 1967. A mental health consultation program in a small community with limited professional mental health resources. See. Ref. 86, 214–36
337. Srole, L., Langner, T. S., Michael, S. T., Opler, M. K., Rennie, T. A. C. 1962. *Mental Health in the Metropolis, Vol. I*. New York: McGraw-Hill
338. Stendler-Lavatelli, C. B. 1968. Environmental intervention in infancy and early childhood. See Ref. 98, 347–80
339. Stennett, R. G. 1965. Emotional handicap in the elementary years: phase or disease? *Am. J. Orthopsychiat.* 35:444–49
340. Stollak, G. E. 1969. The experimental effects of training college students as play therapists. See Ref. 155, 510–18
341. Stover, L., Guerney, B. G. Jr. 1967. The efficacy of training procedures for mothers in filial therapy. *Psychother. Theory, Res., Pract.* 4:110–15
342. Strupp, H. H., Bergin, A. E. 1969. Some empirical and conceptual bases for coordinated research in psychotherapy: a critical review of issues, trends, and evidence. *Int. J. Psychiat.* 7:18–90
343. Susskind, E. C. 1969. *Questioning and curiosity in the elementary school classroom*. PhD thesis. Yale Univ.
344. Taft, R. 1959. Multiple methods of personality assessment. *Psychol. Bull.* 56:333–52
345. Temerlin, M. K. 1970. Diagnostic bias in community mental health. *Commun. Ment. Health J.* 6:110–17
346. Terrell, D. L., McWilliams, S. A., Cowen, E. L. 1972. Description and evaluation of group work training for nonprofessional aides in a school mental health program. *Psychol. Schools* 9:70–75
347. Torrance, E. P. 1965. *Rewarding Creative Behavior: Experiments in Classroom Creativity*. Englewood Cliffs: Prentice-Hall
348. Trickett, E. J., Kelly, J. G., Todd, D. M. 1972. The social environment of the high school: guidelines for individual change and organi-

zational redevelopment. See Ref. 144, 331–406

349. Trickett, E. J., Todd, D. M. Assessment of the high school culture: an ecological perspective. *Theory Into Practice.* In press
350. Truax, C. B. 1967. The training of nonprofessional personnel in therapeutic interpersonal relationships. *Am. J. Public Health* 57:1778–91
351. Turner, R. J., Cumming, J. 1967. Theoretical malaise and community mental health. See Ref. 86, 40–62
352. Umbarger, C. C., Dalsimer, J. S., Morrison, A. P., Breggin, P. R. 1962. *College Students in Mental Hospitals.* New York: Grune & Stratton
353. Vander Berghe, P. L. 1967. *Race and Racism.* New York: Wiley
354. Wahler, R. G., Winkel, G. H., Peterson, R. F., Morrison, D. C. 1965. Mothers as behavior therapists for their own children. *Behav. Res. Ther.* 3:113–24
355. Walker, C. E., Wolpin, M., Fellows, L. 1967. The use of high school students as therapists and researchers in a state mental hospital. *Psychother. Theory, Res., Pract.*, 4:186–88
356. Ward, C. H., Beck, A. T., Mendelson, M., Mock, J. E., Erbough, J. K. 1962. The psychiatric nomenclature: reasons for diagnostic disagreement. *Arch. Gen. Psychiat.* 7:198–205
357. Weinstein, L. 1969. Project Re-Ed schools for emotionally disturbed children: effectiveness as viewed by referring agencies, parents and teachers. *Except. Child.* 35:703–11
358. Westman, J. C., Rice, D. L., Bermann, E. 1967. Nursery school behavior and later school adjustment. *Am. J. Orthopsychiat.* 37: 725–31
359. Wilkerson, D. A. 1970. Compensatory education: defining the issues. See Ref. 171, 24–35
360. Willems, E. P., Raush, H. L., Eds. 1969. *Naturalistic Viewpoints in Psychological Research.* New York: Holt, Rinehart & Winston
361. Williams, R. H., Ed. 1962. *The Prevention of Disability in Mental Disorders.* Washington, D. C.: US Dep. HEW, PHS Publ. 924
362. Williams, R. H., Ozarin, L. D., Eds. 1968. *Community Mental Health: An International Perspective.* San Francisco: Jossey-Bass
363. Zax, M., Cowen, E. L. 1967. Early identification and prevention of emotional disturbance in a public school. See Ref. 86, 331–51
364. Zax, M., Cowen, E. L. 1969. Research on early detection and prevention of emotional dysfunction in young school children. See Ref. 212, 67–108
365. Zax, M., Cowen, E. L. 1972. *Abnormal Psychology: Changing Conceptions.* New York: Holt, Rinehart & Winston
366. Zax, M. et al 1966. A teacher-aide program for preventing emotional disturbance in primary grade school children. *Ment. Hyg.* 50: 406–14
367. Zax, M., Cowen, E. L., Rappaport, J., Beach, D. R., Laird, J. D. 1968. Follow-up study of children identified early as emotionally disturbed. *J. Consult. Clin. Psychol.* 32:369–74
368. Zigler, E., Phillips, L. 1961. Psychiatric diagnosis: a critique. *J. Abnorm. Soc. Psychol.* 63:607–18
369. Zimiles, H. 1967. Preventive aspects of school experience. See Ref. 86, 239–51
370. Zubin, J., Freyhan, F. A., Eds. 1967. *Social Psychiatry.* New York: Grune & Stratton
371. Zunker, V. G., Brown, W. F. 1966. Comparative effectiveness of student and professional counselors. *Personnel Guid. J.* 44:738–43
372. Zusman, J., Hannon, V., Locke, B., Geller, M. 1970. *Bibliography on Epidemiology of Mental Disorders.* U. S. GPO: NCMHI Publ. 5030

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SCALING

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The premise of the following review is that scaling or measurement is not simply the assignment of numbers to events according to rule. On the contrary, it is rather that meaningful scaling only takes place when several ingredients exist. The first of these is a set of data relations which are at least fairly consistent and moderately numerous. A second requirement is the existence of a mathematical model whose variables can be matched with the empirical conditions and the relations among them. This, together with solution procedures, provides a basis for solving for numerical values of the variables in the model, and it is these numerical values attached to empirical conditions which are the "scales." Moreover, unless the scales have a use external to the immediate set of data from which they have been derived, the scales serve no real function except perhaps as one form of verification of the model. Correspondingly, this review concentrates on contributions to (*a*) describing the conditions which data relations must satisfy in order to provide scales (measurement theory); (*b*) models which may be used for scaling; (*c*) methods for the solution of models; (*d*) the demonstration of external validity for the scales so derived.

Instances of the application of scaling methodology in a straightforward manner are not noted as such. Testing and factor analysis are not included here because they are covered separately, although in their more sophisticated applications they fit well into our paradigm.

The scope of the survey on which this review is based was intended to be rather wide, covering most of the major English language sources (the amount of literature in other languages is significant and growing rapidly), but it cannot be claimed to be complete. Space restrictions led to several compromises with full coverage. With a few exceptions, a decision was made to limit, the literature cited in the review to materials already published in regular journals and books. Some references are noted only tersely, sometimes at grave injustice to their importance, and in some cases multiple references by the same author on related topics are omitted. The reviewer regrets all these inadvertant and deliberate omissions, and hopes that the authors involved will be tolerant of his choices among injustices. Much important literature exists only in technical report or other mimeographed form, an undesirable state of affairs.

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The major subdivisions of this review are AXIOMATIC MEASUREMENT THEORY, QUANTITATIVE MEASUREMENT MODELS, MULTIDIMENSIONAL SCALING, UNIVARIATE SCALING, PSYCHOPHYSICAL RELATIONS, and GENERAL SOURCES. This organization, which does not correspond to the segments of the scaling process presented at the outset of the review, more nearly represents the manner in which the literature organizes itself in terms of sources and cross-references.

AXIOMATIC MEASUREMENT THEORY

There would probably be considerable agreement with an assertion that the two most seminal publications in measurement in the 1960s were the Luce-Tukey conjoint measurement paper (141), and Shepard's paper on nonmetric multidimensional scaling (179). The importance of these publications lies in the fact that they showed ways in which psychologists could be freed from the restrictions imposed by the low level of measurement which they had felt characterized the data: consistent ordinal relations were shown to impose interval or ratio scale structure. Quite different approaches were used for this purpose. The Luce-Tukey approach can be termed the axiomatic one, while Shepard's was one of adopting an explicit functional model. The most important publication in the current period was undoubtedly *Foundations of Measurement* by Krantz, Luce, Suppes & Tversky (126), which provides an integration of the major developments in axiomatic measurement theory.

There is not enough space in a general review such as this to discuss the book with any degree of completeness, so the comments here are limited to some on its general characteristics and approach. It is also referenced in the subsections below on a number of specific topics.

The authors' intention was apparently to summarize, integrate, explain, and expand upon material which was published elsewhere, as well as to present some largely new theoretical developments. One chapter presents the problems, sketches the approaches that will be taken, and discusses a number of strategic and philosophical problems very sharply and clearly. It is followed by chapters on basic mathematical results, extensive measurement, difference measurement, probability representations, several forms of conjoint measurement, finite structures, and one on dimensional analysis.

Throughout the volume the authors show a strong concern with clarity of presentation and succeed in their efforts to a high degree. The focus, of course, is upon sets of axioms and the representation theorems that can be deduced from them. The authors are not content to merely list the axioms and give the proofs. They begin the chapters with material that provides the motivation for the axioms, they discuss the relevance and interpretation of each, and even give frank, critical evaluations of the desirability of basing a system for real data on such a set. Formal proofs are preceded by informal discussions of the general approach taken in them. The chapters end with several pages of (strenuous) exercises. Thus the authors have made a very great effort to meet their readers more than half way, but the difficulty of the material may mean this is not far enough for many readers. The book can be read on many levels, however, and patient readers will find it worthwhile whatever their level.

CONJOINT MEASUREMENT

There were a number of other extensions and clarifications of conjoint measurement during the review period, but fewer examples of application of the axiomatic principles than one might have expected. The difficulty perhaps lies in bridging the gap between the conditions which the axioms imply and the realities of data in the finite case. Krantz & Tversky (124, 127) attempt to ameliorate the situation with a discussion of the nature of the axioms and how they will be reflected in data and thereby used to decide some historically important substantive questions. Krantz et al (126) include similar discussions in their treatment of conjoint measurement, which is based on a somewhat different axiom set than the original. Fishburn (70, 72), Domotor & Stelzer (52), and Krantz et al (126, chap. 8) describe conditions under which special types of additive representation are possible, particularly ones in which probabilities are involved.

A point made in the axiomatic literature is that part of the utility of the axioms is that they provide ways of formulating regularities in data which may be very useful alternatives to the stronger functional statements of the typical mathematical models. Coombs & Huang (43) apply this approach to the study of judgments of "riskiness of bets," concluding that the ordinal relations in the data support a distributive model rather than an additive one in the case of most subjects. An independent study within the same general framework is one by Wallsten (212) in which the patterns of indifference relations among bets were examined and found to be consistent with a subjective utility model. The reviewer remains unconvinced that naive persons in real-life situations behave in ways that resemble more than vaguely the principles of formal probability, however.

In formulating an axiomatic basis for a measurement system, the empirical realizability is as important as their mathematical elegance. Therefore, papers such as Holman's (106) use a more reasonable axiom set as a basis for conjoint measurement, and the attempt by Adams et al (3) to clarify the distinction between "necessary" (i.e. empirically important) and "technical" axioms provides useful antidotes to hyperabstraction.

A somewhat different development is Levine's (133, 134). He points out that in a variety of areas the key empirical statement is that certain curves should be parallel. If they turn out not to be, a possible alternative to rejecting the theory is that they could be made parallel by some change in the form of the dependent variable. He formulates a set of conditions under which it is possible to render them parallel, and he provides some simple, graphic means of finding the required transformation. This is a development of considerable promise for use, for example, under signal detection theory. One also wonders whether this approach might fruitfully be applied to psychophysical data such as Indow's (110) and Gregson's (87, 88) in the area of taste.

Krantz (121) formulates a special algebraic system for a specific problem, the matching of mixtures of colored lights, an area where the empirical relations are of an elegant regularity. It may well be argued that it is more desirable to develop systems like this which meet the particular needs of a limited domain that behaves with great regularity, rather than to try to develop general models of wide applicability, such as the basic ones of conjoint measurement theory. Egeth et al (57) studied a problem, for example, where an approach similar to Krantz's might have proved fruitful.

Kristof (129) develops an axiom system for application to tasks like bisection. Fagot & Stewart (65) report a test of the bisection theory included in Pfanzagl's important book (158), using brightness judgments and verifying that midpoints of intervals correspond to midpoints of midpoints, etc. A characteristic of their test, which deserves wider emulation, was that of fitting a model to one set of data and validating the parameters thus derived by using them to predict the values of other independent observations rather than simply observing the overall fit of the data to the model.

ORDINAL RELATIONS

Orders are important in their own right as well as prerequisite to several stronger forms of scaling such as nonmetric multidimensional scaling and conjoint measurement. Such orders are most meaningfully developed from consistent binary relations, of which the most straightforward example is the asymmetric, connected, and transitive simple order. Over the years there have been a number of attempts to provide sets of axioms that reflected the various sorts of discrepancies from this neat arrangement which appear in data, while still providing some form of order. Several interesting papers in this vein appeared during the period under consideration.

A problem which arises in the context of discrimination as well as preference is that of "intransitive indifference," in which the relation observed resembles equivalence in being symmetric and reflexive but turns out not to be transitive. Roberts (166, 167) and Fishburn (71) have extended the study of this and related problems, employing methods from the theory of mathematical graphs. They give similar results, assigning to each point two numbers (u, p), with p positive, such that x is preferred to y if $u(x)>u(y)+p(y)$. Roberts (167) goes on to apply related concepts to situations where the empirical "preference" relation observed is, for example, a probability greater than one half, showing that this allows the generation of families of semiorders. The latter results would appear to have relevance to the development of families of consistent discriminability scales in the manner of Fechnerian psychophysics.

In an interesting paper, Ducamp & Falmagne (55) explore means of characterizing binary relations on A×B rather than A×A. They show in a very clear way what patterns of relations must exist for consistency in such cases. Particularly important is their work on the "bi-quasi series," of which the Guttman scale is an example, and the related "bi-semiorder," showing that an ordering for both persons and items, for example, may be derived, as long as the following pattern (e.g. for persons a, a′ and items b, b′ where 1 represents pass and 0 fail) *does not* exist for any pair of pairs:

$$\begin{array}{ccc} & b & b' \\ a & 1 & 0 \\ a' & 0 & 1 \end{array}$$

This paper, and others, illustrates the usefulness of graph theory, and especially its matrix representations, in the definition of consistent patterns of binary relations.

In this as well as in other examples of an axiomatic approach, however, the problem of what can be salvaged when there is some degree of inconsistency in the relations remains an unsolved one, in spite of efforts like Holman's (105), because empirically the departures are inconsistent and therefore hard to formalize.

EXTENSIVE MEASUREMENT

Extensive measurement is the kind applied to ordinary physical quantities, and its main distinguishing property is the availability of an operation concatenating two quantities of the same kind to yield a new quantity of that kind in a regular manner. It was largely the necessity for finding alternatives to it that would not involve such concatenation operations that has motivated the blossoming of recent developments such as conjoint measurement. This treatment remains of considerable interest to measurement theorists, as shown by Krantz et al (126, chap. 3), because it avoids certain of the difficulties of other treatments, drawing on Holman's (105) as well as Roberts & Luce's (168) paper on thermodynamics, and it includes many surprising features. Other contributions include a paper on Holder's theorem, which is central to extensive measurement (66), and a formulation of the distinction between density and length (28).

Among the attractive features of the Krantz et al (126) presentation of extensive measurement is their forthright discussion of the empirical adequacy of the axioms, particularly the solvability axiom which requires that for two weights, for example, it is always possible to find a third to concatenate with the lighter so as to make the combination at least as heavy as the heavier, and the Archimedean axiom which requires that it be possible to concatenate a weight with itself an unlimited number of times.

COMMENTS

The recent achievements of axiomatic measurement theory provide hardly less than the basis for a revolution in the definition of psychological variables. They free the investigator from having to assume that some physical or objective index is, in its literal form, the psychological variable. The axiomatic systems show how he can use the data relations themselves instead to define, or at least narrowly limit, the nature of his variables and the forms of his theories. Given this opportunity, it must be said to be a disappointment that more advantage has not been taken of it.

The reasons for this slowness of effect on the psychological community as a whole are probably several. First of all, the mathematics it involves are exotic to almost all psychologists. Second, the empirical work done has seldom been of the *fine-grained* nature which is noted (204) as essential for true application of the principles. Third is the relative failure to handle the difficulties posed by the inconsistencies inherent in fallible data, and the relative lack of axiomatically based computer programs to analyze the data (cf. Lingoes' work, e.g. 135, and Kruskal's *Mononova*, cited in 130). Attention to these gap-bridging problems seems preferable to development of further esoteric axiomatic systems. It is likely, however, that one really striking empirical example in which the axiomatic measurement theory approach led to a marked simplification of an area or to an important new substantive insight would do even more toward convincing psychologists that the concepts are worthwhile.

SCALING WITH FUNCTIONAL MODELS

The average social scientist's conception of scaling is the assignment of numbers by subjects to stimuli, perhaps according to some sort of instructions requiring them to keep intervals or ratios equal. One should not lose sight of the fact that, with few exceptions, any given judgement is taken as part of a larger relational structure, including very often a fairly elaborate model in which the scale values are *not* the numbers assigned judgmentally, but some other set of parameters derived from them. Even in the case of the ratio judgment methods developed by Stevens (196), it is the power law relation to the physical continuum which gives the ratio property, not the instructions to the subjects to judge ratios, and the scale is the power function fitted to the physical scale, not the judgments themselves. Moreover, judgments and choices are merely one type of data, albeit historically the most convenient, that can be analyzed to yield scale values.

A segment of the psychological community has perhaps always been fully aware of the fact that scaling could take place with a wide variety of kinds of data and models, and that scale values arrived at by judgment methods could be subjected to a secondary analysis to arrive at stimulus parameters. Gulliksen (92) gives several examples of both kinds, and not only multidimensional scaling but even factor analysis are examples of solving a model for a set of stimulus parameters which describe the relations among the observed data. A notable feature of the period under consideration, however, was increased appreciation of the breadth of the class of models which can be used for scaling.

SUBSTANTIVE MODELS

Several papers provide illustrations of the application of these principles. Anderson and his co-workers present several (7–10, 178), primarily in the context of several types of application of a weighted average model for the judgment of composite stimuli. Indow (111, 112) did a series of studies of the preference value of composite stimuli, finding a variety of apparently consistent forms of the relation of composite stimuli to the components, including an instance of pure or literal additivity. Svenson (197) found that a multiplicative model described the relation between judgments of the time required for journeys and the rates of speed and the distances gone, and this was not the same as the literal physical relation. Sjöberg (185) found that such models accounted for the judgments of heaviness of stimuli and the desirability of lotteries (184). Undoubtedly there exist in the literature various other examples of similar procedures. Some which are more closely tied to explicit scaling or choice models are dealt with later in the section on univariate scaling.

Some authors incorporate a scaling procedure in the model itself. Thus Bock (22) not only presents a model for choice data but also derives a multivariate statistical method to estimate the underlying scale values. Bechtel in several papers (e.g. 16, 17) presents analysis of variance methods for the testing of models for difference judgment and the estimation of the stimulus parameters involved; the model should be easily adaptable for other weighted combination models. Bogartz & Wackwitz (23) contribute to the solution of the problems of how to accomplish the monotonic rescaling of the response variable, although their model requires the estimation of as many parameters as there are stimulus combinations, which may limit its usefulness when there are many data points.

Undoubtedly the most frequent example of use of a functional model for the purpose of scaling is the Euclidean distance model and its relatives. The literature on it, however, has become so extensive that it is treated in a separate section.

SCALING METHODS IN SIGNAL DETECTION

The theory of signal detection (TSD) is primarily an explanatory model for various sorts of decision behavior, particularly in sensory contexts. Fairly frequently, however, there is direct interest in estimating *d'*, the detectability parameter of a given stimulus, and sometimes also in finding *c*, the value on the simulus continuum of the decision criterion. Some recent papers provide elegant bases for estimating these parameters, and these and other papers make it clear that TSD, as a basis for scaling methods, is very close to the Thurstone models.

Statistical estimation theory provides the basis for estimation methods in TSD. Ogilvie & Creelman (154) derived maximum likelihood estimates for *d'* and *c* as do Dorfman & Alf (53). The latter build on some results for Thurstonian successive intervals scaling and do not assume equal variance for noise and signal-plus-noise. Abrahamson & Levitt (1) provide several procedures for estimating *d'* which include but go beyond the normal distribution and equal-variance cases, including some tests of hypotheses. Marley (145) discusses sets of conditions under which a signal detection response process will have a distribution function satisfying certain general criteria. Richards & Thornton (165) suggest a rather straightforward least squares method of estimating *d'*. These and other papers provide a substantial amount of estimation power for TSD to go along with its explanatory usefulness.

Wickelgren (215) examines the consequences of assuming variance in the decision criterion, noting that the experimental methods that have these effects tend to be avoided. He also comments on the fact that *d'* values estimated for a given stimulus from different experimental procedures should be related, and notes that this consistency is sometimes confirmed. Dorfman & Alf (53) report exceptions, however.

The relation between TSD and Thurstone models exploited by Dorfman &

Alf (53) was only part of a more general recognition of the resemblances between them in spite of their different purposes. Lee (132) comments on a number of these. Two papers (2, 210) studied social stimuli by TSD methods. It will be interesting to see how useful TSD becomes as a scaling model, especially in terms of how much it adds over the similar scaling methods that have been available.

The reviewer also feels that it would be desirable to examine large amounts of TSD data with a relatively open mind before attempting to specify the exact form of a distribution, decide whether variances are constant, etc. Moreover, the development of the relatively scale-free principles of conjoint measurement lend to support a program in which *d*s and *c*s are estimated by those means, and only then are attempts made to reconcile the obtained values with one or the other particular statistical model.

GENERAL CONSIDERATIONS IN SCALING THROUGH MODELS

Anderson's paper (8) articulates a number of useful points, although the way in which it presents some material has provoked comment (e.g. 128). Anderson presents several models for various kinds of data, and in a manner similar to Gulliksen's (92) shows how they may be solved for their parameters, a process which he terms "functional measurement." He also reminds us that a priori the response scale can very often only be defined as monotonically related to the variable of primary interest, and that therefore a monotonic transformation to bring it into better agreement with the model may be often justifiable. He further (pp. 166–68) emphasizes the importance of validation of the response scale used by such features as showing (*a*) that similar transformations are required for similar kinds of data, or (*b*) that transformed scales relate better to other variables. Cliff (34) provides instances of the latter and makes a number of similar points (36, 38). A scale cannot stand alone; it must be supported by a network of relations, and the broader and tighter the network, the more confidence there is in the scale. Axiomatic measurement theory, particularly conjoint measurement and its relatives, reinforces this principle by defining clearly the relations that must exist among data in order to justify the existence of scales and models of certain fundamental types.

The axiomatic and the functional scaling models represent two philosophically different approaches to measurement, but they perhaps exhibit some degree of complementarity. The former emphasizes the relations that are necessary and.or sufficient to make certain rather generally applicable underlying models valid. The latter says in effect "what if a certain function related the observations to values of underlying parameters?" and proceeds to try to estimate the values of these parameters. Considered abstractly, the former may represent the sounder approach because it is more closely tied to the data relations themselves. As such it may be hoped it will permit a more faithful representation of explicitly psychological relations (127) rather than forcing them into molds that are, after all, more or less closely adapted from physical world models. On the other hand, the functional models seem better able to handle the inherent inconsistency of data, although sometimes at the expense of being able to force a completely erroneous model onto a set of data.

MULTIDIMENSIONAL SCALING

As noted above, multidimensional scaling (MDS) properly belongs to the family of functional models in scaling, but its literature is now so extensive as to warrant separate treatment. Indeed, the avalanche of papers noted by Zinnes (222) now reaches such proportions that papers which simply applied MDS methods were not reviewed. This section is organized under three subheadings: Models, Algorithms, and Methods; Individual Differences and Other Extensions (in which the most important innovations took place); and Validity Studies.

MODELS, ALGORITHMS, AND METHODS

In spite of the variety of technical terms and descriptions used in MDS, the reviewer feels that there is one paramount distinction among analytic approaches. This is in whether or not the original proximity index is taken as a ratio scale. If not, then the algorithm, whether it simply solves for an additive constant or is "fully nonmetric," is *assuming* that the distance model is valid and *using this assumption to transform* the original scale into a derived one which *is*, in a well-defined empirical sense, a ratio scale. Thus the important theoretical distinction is between metric and "not fully metric" approaches.

General and theoretical.[2]—One of the main deficiencies in the scaling literature has been a general text on MDS, a deficiency that was remedied to a substantial degree by the publication of the brief, rather nontechnical book by Green & Carmone (78). While their book has a distinct orientation toward marketing, this does not interfere with its usefulness to other fields. In their own research, Green and his co-workers have faced most of the problems that arise in applying MDS, and this experience allows them to discuss them intelligently and suggest workable solutions. They describe the three main computer programs for nonmetric MDS—TORSCA, MDSCAL, and SSA-I—and pay considerable attention to fitting preference data to multidimensional scaling solutions. They also sketch briefly the main characteristics of factor analysis and cluster analysis as alternative procedures to MDS, and include an appendix describing several dozen computer programs which have application to MDS or problems related to it. There remains a need for a somewhat more technical source, however.

Computer programs often achieve wide circulation before being documented in the literature, and the more widely used ones are in a continual process of revision, due mainly to a lack of edited outlets for computer program documentation. This phenomenon is undesirable from the point of view of development in the field and has the incidental effect of making a review such as this rapidly obsolete in this respect. Thus, it was good to see two substantial papers on the Guttman-Lingoes (G-L) programs published. Lingoes (137) describes the

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[2] Two books which were published too late to include in the reference list should not be overlooked: Green, P. E., Rao, V. R. 1972. *Applied Multidimensional Scaling*. New York: Holt. 292 pp. Also the two-volume work: Romney, A. K., Shepard, R. N., Nerlove, S. B., Eds. 1972. *Multidimensional Scaling: Theory and Applications in the Behavioral Sciences*, pp. 261 and 323. New York: Seminar Press.

G-L series of computer programs to that date and sketches their rationale. Guttman's paper (94) goes more deeply into the latter, providing what is, except perhaps on some historical aspects, the best available theoretical source not only on the G-L procedures but also on the general problem of using ordinal data to determine a metric dimensional structure.

Tversky & Krantz (207, 208) present an axiomatic formulation and empirical test of a generalized distance function whose main features are generalizations of the intradimensional subtractivity and interdimensional additivity which constitute the Euclidean distance formula. Their data tend to support the general model, but those of Wender (214) are less encouraging. Micko & Fischer (150) give an axiomatic formulation of general Minkowski distances. Their paper includes a good discussion of the mathematical properties of spaces of various kinds and also a thoughtful one of the psychological processes that may lead to one form rather than another. They conclude, as others have, that metric representations may be relatively insensitive to the exact form of the distance function.

Several papers were published on specific technical aspects of MDS. Lingoes (136) showed that the distances or scalar products among n points can always be transformed to fit into n-2 dimensions, but the rather metric nature of his proof suggests that there may be a stronger boundary in specific cases. Two papers (130, 131) were published on goodness-of-fit functions. Cooper (44) derives a solution to the special cases in which the transformation of the proximity scale is restricted to the general linear one.

Artificial data analyses and the problem of error.—There were several evaluations of the nonmetric programs using artificial data. Two useful papers (120, 190) present information concerning the distribution of Kruskal's stress when the proximities are completely random. Both studies found strong effects on Kruskal's stress of both number of points (n) and dimensionality (r), and an appreciable interaction of the two; very low stress values can occur when ten points are analyzed in three or more dimensions.

Spaeth & Guthery (188) found a disturbing number of failures of MDSCAL and SSA-I to recover configurations with error-free data, SSA-I doing a little the better. On the other hand, Green et al (86) seem to find good results for the same configurations for TORSCA, but this conclusion is to be interpreted cautiously, since they always analyzed in the "correct" dimensionality. Young (220) and also Wagenaar & Padmos (211) studied the effects of adding random error to fixed configurations upon the stress values obtained and upon the match of the obtained solution to the original one. In addition to the expected effects of error magnitude, Young found that recovery *improved* with number of points while stress *increased*. The problem of how error should be introduced in Monte Carlo studies is a complex one, and the procedures adopted affect the conclusions of such studies. Young discusses many of the issues thoughtfully, but there is not yet any final consensus. Several other Monte Carlo studies were in various unpublished forms at the time of the review. While conclusions about studies of computer programs may be highly dependent on the exact versions studied, the persistent evidence from empirical as well as artificial data sources that MDSCAL may on occasion be highly sensitive to the starting configuration used is worth noting. Ramsay (162) studied theoretically the statictical characteristics of MDS. When his assumptions are realistic it seems quite possible that the available programs are distinctly suboptimum as ways of estimating in the statistical sense the coordinates of the points.

Also relevant to the problem of error were several papers on widely differing subjects. More data like that of Ekman & Kuennapas (62) would shed light on what kind of error functions to use in Monte Carlo studies. Green & Rao (85) did a Monte Carlo study of the question of how many categories to include in a rating scale, concluding that six categories resulted in recovering appreciably more information than three and almost as much as 18 did. They also studied the number of "scales" needed to define a dimension in semantic differential-like methods. The same authors (84) also investigated various aspects of alternate ways of analyzing the scores of n objects on p measures, including the effect of various different proximity measures that can be used in that context.

Two papers suggested ways of matching MDS solutions. One (30) sketched a procedure which can be used to compare the MDS solutions obtained from three or more sets of data. The second (177) showed that two solutions could be compared by centering both solutions at the origin and employing an orthogonal Procrustes procedure. It may also be pointed out that an ordinary multiple regression program can be used to define the oblique transformation which aligns one solution with another in an optimum way.

Other models and situations.—Most of MDS focuses on procedures for analyzing symmetric matrices in which the entry is assumed to represent distance or some qualitatively close analog of it. Other types of data and interpretations of the proximity index exist, however. Ekman's vector model for similarity judgment, which assumes that a judgment is a scalar product between vectors, was the stimulus for several papers (40, 60, 149, 151). Micko (149) proposed an alternative model for analyzing judgments of the kind "how much of stimulus i is contained in stimulus j?" which had several interesting methodological and psychological features. Ekman (60) compares his vector model to standard MDS results on several sets of data, arguing that the reduced dimensionality obtained by the latter is often at the expense of reduced interpretability of dimensions. Rotation and origin location so as to yield the most valid interpretation is indeed a troublesome problem in many applications of MDS, but Ekman's discussion seemed to fail to differentiate between artifact dimensions, the effect of placing the origin at the centroid, and the effects of nonmetric transformations.

Sometimes proximity matrices are systematically asymmetric because of the experimental task, a situation which calls for special methods. This can be because the row and column indices run over different sets, as if the distances from each of several cities in North America to each of several in Europe were known, but none of the within-continent distances were known. Schonemann (176) provided an exact method for finding the coordinates of both sets of points relative to the same basis, whereas previously the relative positions of the points were definable only within sets. Another form of the same problem occurs if the data consist of "conditional proximities." Here we have for each point the rank order of the distances of each other point from it, but the complete ranking is not directly known. Green & Maheshwari (81) utilize an option of MDSCAL which makes it possible to analyze such data, and compare this to a "triangularization" procedure suggested by Coombs (41), concluding that even with error in the data, both methods are quite effective in recovering the configuration, with triangularization perhaps working better at the lowest error levels but MDSCAL being more robust in the presence of error. Another form of data to which MDS is occasionally applied is the method of triads. Roskam (170) discusses various ways in which such data can be analyzed to recover an ordering of the distances between a set of *n* points, and tests the methods with a Monte Carlo study.

Particular content areas are likely to inspire special methods and adaptations of standard ones. Gregson (87-89), working in the area of taste, describes special methods developed for analyzing data from the area of taste, but large-scale employment of standard methods might prove equally useful here.

Conclusions.—Developments within the basic MDS methodology were thus primarily conceptual and technical refinements, not innovations. Among the unfilled needs is some sort of statistical basis for deciding such questions as the number of dimensions which can be reliably defined and the uncertainty of the coordinates of a given point. This would be much more valuable than tests of the null (nullest!) hypothesis that the proximities are random. Failing such developments, MDS is likely to drift into the inferential quagmire that holds most of traditional factor analysis.

INDIVIDUAL DIFFERENCES AND OTHER EXTENSIONS

The first methods suggested for handling individual differences in the perception of stimuli were derived from factor-analytic bases; they were subject to a certain type of misapplication, although that could be avoided (37).

Recent developments include recognition of the specific nature of the problems and well-formulated solutions to them. Horan (107) and Micko & Fischer (150) showed how averaging data from individuals with differing perceptions could lead to results which not only were distortions of the view of any single judge but also might not be Euclidean, even when the individuals were behaving Euclideanly, and this may explain results from some studies (e.g. 6).

The general theoretical approach is to allow individual difference parameters in the distance model. McGee (148) allows each of N judges to have unique transformations of the response scale or unique configurations or both. The most complete formulation, and the theoretical MDS paper which probably excited the most interest, was provided by Carroll & Change (31). Their approach is a general one in which MDS (primarily metric although a nonmetric feature is included) is a special case. The result is a set of stimulus loadings on "group" dimensions, representing those used by any judge, and a matrix of weights representing the degree to which each judge employs each of these dimensions. It is related to three-mode factor analysis (203) but is more explicit and somewhat simplified. Several applications of it were primarily reported by Wish and co-workers (32, 181, 216, 217) with results that almost always appear successful and interesting. This method appears to provide fruitful avenues for application.

One of the more difficult situations in which to apply nonmetric MDS is that in which the configuration is of mixed dimensional and cluster structure because this is likely to give either a degenerate solution or misleading dimensions. Degerman (50) suggests methods for handling such data by looking for hyperplanes in the space. Maruyama (147) also studied the problem of finding a smaller dimensional manifold within a space of given dimensionality.

VALIDITY OF MDS

Comparison of structures obtained from different sets of data.—As noted at the outset, a focus of this review of MDS literature is data which bear on the question of whether MDS structures have substantive validity beyond merely summarizing the data from which they are derived. A related question is whether different sets of data, e.g. different kinds of judgments, yield substantially the same structure. They were a number of studies of this type. Several workers (26, 48, 180, 218) did studies in which visual stimuli, and also names of them, were judged, finding configurations with considerable similarity, supporting the notion that similarity judgments tap some cognitive map of the stimuli.

There were also several studies of the effects of different modes or criteria for judgment. Yoshida et al (219) compared structures from similarity judgments and from category clustering of adjectives. Henley (100) compared the structures obtained from five different kinds of data on animal names, finding substantial correspondence in dimensions from some but little for two of them, perhaps because they did not reflect semantic similarity very accurately. Lund (142) analyzed triad and magnitude judgments. Two studies (25, 221) compared response latency and judgments as indices of dissimilarity. All of these studies found similar structures for at least some of the methods. Aiken & Brown (4, 5) analyzed judgments of discriminability of visual forms, finding congruent configurations for two judgment methods but substantial differences from one obtained from their actual discriminability. In two studies (69, 79) subjects were asked to judge similarity of stimuli with respect to particular, presumably unidimensional, characteristics, as well as to judge overall similarity. In both cases there were a substantial number of failures to find the dimensions derived from the specialized judgments in those derived from the overall judgments, but the failure may be attributable to the relations being curvilinear or to inconsistency of judgment. However, these failures, along with the finding that there were differences as well as similarities in the structures found in a number of the other studies cited, suggest that MDS gives the main stimulus dimensions but perhaps not all of those that the judge is capable of using, and not always in exactly the same form.

Several studies (11, 82, 83, 153, 216, 218) compared structures obtained with

MDS to those from semantic differential-like bipolar rating scales. Their results showed some consistencies and some differences in the methods which perhaps are to be explained by the fact that in procedures like the semantic differential the dimensions are in effect weighted by the number of *scales* representing each rather than directly by their importance to the subject. This has two possible effects. First, any stimulus dimension not represented in the scales will not emerge from the semantic differential analysis even though it is important for differentiating stimuli. Moreover, the dimensions that are found are weighted by the number of scales representing them as well as by their salience to the judge, so D^2 may not correlate too highly with similarity, even though the dimensions recovered from both may be similar. The reviewer feels that MDS is the preferable technique for determining the salient stimulus dimensions because it imposes the least restriction on the basis by which the judge makes his responses and most validly reflects the importance he attaches to them.

MDS structures and unidimensional judgments.—Perhaps the most persuasive evidence for the validity of structures from MDS came from the studies in which a variety of other responses were shown to bear direct quantitative relations to them. The most common study of this type related some sort of liking or preference measure to the dimensions. Several studies (24, 51, 81–83), notably by Green and his co-workers, are good examples, showing close relations between preference and position. One study (80) of liking for television shows failed to find close relations, however. Most studies have found that the degree of liking increases the further one goes in some particular direction in the space, but some (35, 189) find cases more consistent with there being a preferred locus in the space, with liking decreasing as a function of distance from this place. Other more complex functions relating preference to dimensions have turned up in some as yet unpublished studies. The complexity of the results to date can be interpreted as validly reflecting the nature of human value judgments, which can undoubtedly take on a variety of different relations to the perceptual dimensions, depending on the domain and the judge. Also, as in the television program study, it is probably true that in some instances preference is determined not only by the dimensions or typologies that determine the gross structure, but rather by highly specific traits that differentiate among stimuli that are close together in it. Multidimensional scaling is apparently useful in finding out which of these situations is true, as well as in the exact form it is taking in a given instance.

While preference sometimes follows a generalized unfolding model in its relation to a multidimensional space, attempts to use unfolding procedures themselves have not been notably successful in revealing the more general perceptual structure. Such failures probably occur when there are not enough ideal points present in the sample to determine the structure. The "vector" type procedure of Bechtel et al (18) may have similar difficulties since it also relies on the lack of a consensus as the means of defining dimensions.

A more theoretical analysis of the relations between preference and dimensions was carried out by Tversky (206). He explored the different kinds of relations that can exist between the relative liking for two stimuli and their relative positions on dimensions, suggesting examples of intransitive preference and explaining them in terms of a plausible response model.

Several investigators have found that other unidimensional judgments of stimuli, particularly words, fit into the space found by MDS analyses of judgments of similarity. Several studies (33, 39, 169, 205), in addition to those cited above on the semantic differential, found that position on individual rating scales were highly correlated with one direction or another in the MDS space. One (33) also found evidence that suggested that personality inventory responses related to the positions of the items in a semantic meaning space relative to the respondent's self-concept or *persona.*

Other studies investigated other sorts of stimuli and unidimensional judgments. Cliff & Young (39) report that judgments of the emotional intensity of facial expressions behaved as if they were distances from an implied "origin" in the space. Also, the degree of military threat which was judged to be posed by simulated air raids was a fairly direct function of their locations in a conceptual space derived from similarity judgments; the defensive measures selected were also a direct—but different—function of the raids' positions in this conceptual space. Isaac (114) found MDS results valid for predicting subjects' responses to a rather unique task, predicting which stimulus would be picked out as the "odd one" from a tetrad of stimuli. Clearly, a variety of judgmental tasks are consistent with MDS results.

Two studies were relevant to MDS's sensitivity to the particular stimulus set used. Green et al (82) found that the proximities among five stimuli were virtually unaffected by which of two larger sets they were included in for judgment. Indow & Matsushima (113), on the other hand, found that judgments of colors selected from limited areas of the color solid were virtually unidimensional. It appears that there may be two questions involved here. One is perceptual-judgmental, asking whether the judgments themselves are affected enough by contexts to result in substantially different structures. The other is perhaps more related to methods of analysis and the amount of error in the data, asking whether restricting the range of a dimension may result in its character being so obscured by error as to be lost.

In addition to providing empirical data, Cliff & Young (39) presented a formulation in which to embed a variety of scaling results. They hypothesized that the individual carries with him an organized structure for a given set of stimuli, and that the variety of different responses he may make to them are to be understood as various different mathematical functions of this structure. Moreover, they felt that MDS analyses of judgments of similarity or similar responses yielded an approximation to this structure.

Transactions between MDS and other aspects of psychology.—The methodology of MDS and concepts derived from it have begun to show usefulness to problems in the more traditional areas of psychology. Hyman & Well (108, 109) showed that the exponent in the distance function (city block vs Euclidean) may provide a useful index of the degree to which stimulus dimensions are integrated rather than separately considered. Garner & Felfoldy (77) found these concepts useful in explaining behavior in a sorting task. Slak (187) proposed that the channel capacity of various sensory modes combines as a Euclidean distance function to the separate modes, and provides data in support of this contention. Arnold's (11) results suggest that the subject can adopt several different metrics, depending on the task and stimuli. Data of the types cited above might lend themselves well to the more formal concepts of Tversky & Krantz (207, 208) than to the simple functional approach usually studied, however.

There were some studies in which MDS solutions were cast in the role of dependent variables. Among these was the study by Friendly & Glucksberg (76) which showed systematic differences in semantic meaning spaces between subgroups, interpreting the differences as a function of absorption into a subculture. MDS could be used to evaluate change resulting from training or education. Rankin et al (163) provide a beginning in this direction, and the study by P. E. Johnson et al (118) could, for example, have been done before and after a physics course emphasizing dimensional analysis. Further uses of these types seem to offer objective but rich methods of demonstrating differences which heretofore could only be described impressionistically or with the simplest frequency counts. So additional studies utilizing MDS structures as dependent variables are anticipated.

At the outset of this review it was contended that scaling had very little purpose unless the results of the scaling analysis were intended for further use and that external evidence of scale validity was important conceptually. From the studies cited here, it appears now amply demonstrated that structures obtained by MDS from indices of subjective similarity do have validity, especially for other judgmental responses. There are exceptions; perhaps these are instances where the MDS structure is not specific enough or not precise enough to be relevant to particular responses. The formulation proposed by Cliff & Young (39) has substantial validity, but it is perhaps optimistic with respect to the accuracy and generality of MDS results.

UNIDIMENSIONAL SCALING PROCEDURES

This section describes recent research relevant to the judgment procedures which are the mainstay of scaling applications: rating methods, magnitude methods, and comparative judgment methods. New methodological developments were relatively few, but there were a number of studies of context effects, of applications of choice theories, of statistical characteristics of methods, and, perhaps most importantly, of the relations between scales obtained by various methods. They are summarized below, but the studies which focus on specifically psychophysical problems, i.e. the nature of psychophysical laws, are treated separately in the next major section of the review.

METHODOLOGICAL DEVELOPMENTS

Among the relatively few analytical papers in this area was Schonemann's (175) formulation of a least-squares estimation procedure for Case V paired comparisons, Phillips's (159) on finding a numerical representation of an ordered metric scale, and Dunn-Rankin & King's (56) arguments for simply counting the votes for each stimulus in paired comparison. Abandoning the use of any specific model for the choice behavior is a step that is contrary to the principles we have focused on here, however. Rule (172) indicated that the average, over subjects, of slopes in magnitude estimation is the harmonic mean of the subject's exponents. In a series of papers, Herrick (101–103) proposes some stochastic properties of the classical psychophysical methods, deriving some specific relations that should exist among their results, reminiscent of relations among signal detection tasks. Clearly, the traditional methods did not excite much methodological interest.

Stimulus presentation controlled by computer program would appear to be a desirable scaling development. One such computerized procedure for systematically altering the stimulus according to some rules in an iterative fashion is described and evaluated by Pollack (160). Additional developments in computer-interactive scaling are under way but not yet published.

PAIRWISE CHOICE MODELS

Papers in this field focused primarily on aspects of Luce's choice model and concepts with a similar orientation. Marley (146), for example, extends a choice theory to provide a theoretical analysis of ranking behavior. Several studies tested or compared choice models experimentally. Rumelhart & Greeno (174) contrasted a simple Luce model with a similar one of Restle's which, like Thurstone's, includes terms describing the "overlap" between stimuli as well as their scale values. They found that this model provided a better fit, on data especially suited for it, than did Luce's simpler one. Tversky & Russo (209) discuss a general type of scaling called simple scalability, applicable to choice probabilities. Simple scalability describes the situation in which the probability that x is chosen over y is a strictly increasing function of a scale value for x and strictly decreasing function of the scale value of y. They argue that properties derived from simple scalability tend to be violated when the stimuli are not homogeneous, i.e. comparable on a single continuum. The stimuli of Hofstel (104) may provide an example of nonhomogeneity. The focus of these papers, appropriately enough, is perhaps more on the models as models than on their use in scaling, but the paper by Freedle & Lewis (75) focuses at least equally on the scaling aspects.

There were several papers related to the unfolding type of approach to pairwise choices. Bechtel's (15) analysis allows the joint estimation of stimulus scale values and the distribution of the subject population on the continuum. The method appears to have useful social-psychological application. However, Hall (97) describes some data relevant to it which seem to support some qualitative predictions of unfolding but not the specific quantitative ones of Bechtel's model. He also (96) reports several sets of paired comparison data which were analyzed by Thurstone and Choice Axiom methods as well as by unfolding, finding that unfolding methods were needed in order to explain judgments of which statement more nearly represented the subject's own views.

The primary usefulness of the various pairwise choice models is in their application to social-cultural rather than simple sensory stimuli, but to the reviewer it seems that experience to date indicates they are of only limited utility as descriptions of the behavior of individual human subject's choices. The problem with the stochastic choice models lies just in their probabilistic nature. At the level of the individual, the choice probabilities are close to unity and zero. Moreover, an attempt to estimate the probabilities by a procedure like repeated presentations has the effect of changing the probabilities. On the other hand, consistent individual differences, especially multidimensional ones, lead to proportions which are inconsistent if one attempts to use subjects as replications. Unfolding might be more valid in these contexts, but it seems to be trying to do too much with a very limited amount of data when it attempts to scale both persons and stimuli from the binary choices, especially if the data is multi-dimensional. The two-stage methods discussed under multidimensional scaling seem much more likely to provide valid descriptions of preference behavior, although the concepts of Tversky (206) also need to be taken into consideration.

THE EFFECTS OF CONTEXTS ON SCALE VALUES

Most applications of scaling methods employ judgments in one way or another, and a persistently aggravating problem is posed by the fact that each judgment is affected by the other stimuli being judged. Recent empirical studies of ratio judgments (63, 171, 186) continue to show such effects. Several sets of several different kinds of pairwise ratio judgments were shown to be inconsistent with any of several models which assumed that the judgments were on a ratio scale (186). Ross & Di Lollo (171) provided a set of data showing particularly sharp stimulus-range effects, reaching a conclusion " . . . that magnitude estimates are made on an interval scale, with a unit and an origin that changes with context." Moreover, they assert that the judge "constructs his estimates of stimuli indirectly, from estimates of difference."

Context effects are well known to occur with category scales, too. Here the interest is as much in studying the effects for their own sake as it is in their biasing effect on scales derived from category judgments. Johnson & Mullally (117) showed that the effect of various experimental parameters upon mean category judgments can be interpreted as the result of statistical considerations such as a regression effect, and that the level of practice of the subjects had an important influence on their ability to place an outlying stimulus appropriately (see also 62). Parducci & Perrett (157) found that the range of values of the set of stimuli as well as the distribution within that range had an effect on ratings of a stimulus. Helson & Kozaki (99) found strong effects resulting from the position of an anchor stimulus relative to the series being judged. The semantic differential is a series of category scales, and Heise (98) gives a thoughtful discussion of how to minimize biases in its use. Corso (45) summarizes the success of adaptation level theory as an explanation of context effects, concluding that the evidence supports the general principle of adaptation level but that additional research is necessary for "its precise formulation in quantitative terms."

The problem of the effect of contexts is actually several different problems. In many practical applications, the goal is to get an approximate interval scale rather than anything more absolute. Since the background has an effect, the goal is to keep the background as constant as possible throughout the judging process so that the judgments of different stimuli are not differentially affected. This motivates the use of devices such as clear directions, warm-up judgments, anchor stimuli, and well-mixed stimulus series. These background standardizing procedures should also have the effect of reducing variance. On the other hand, in certain basic areas such as the determination of the nature of psychophysical relations, there may well be concern that these controls will themselves destroy the form of the relation by biasing the response scale. Since all judgments are subject to these influences, how does one know when he has the "right" set of judgments? There are two types of answers. One is to shift the focus of attention away from the expectation of any "true" scale over to the study in their own right of the changes that are induced. This is the approach of adaptation level theorists and such investigators as Poulton (161) and Ross & Di Lollo (171). (One may remark here on the difficulty of separating perceptual changes from mere changes in the way the response scale is used.) A second strategy, one which has considerable historical support in scientific practice, is to say that the "right" set of procedures is the one that yields the scales which bear the simplest relations to other variables. This is the basis for many of Stevens' arguments (e.g. 191). Which of the two attitudes is the superior one depends on the importance of the discoveries made by studying the effects of the extraneous variables on the one hand and upon which relations are judged to be simpler and most numerous on the other.

Somewhat related to context effects are several papers on the distributional characteristics of judgments. John (116) found that, for magnitude estimate judgments, the index of variability ($\bar{x}/s$) increases with stimulus. In two studies (115, 116) he found that an information measure of uncertainty was a curvilinear function of stimulus value, being highest in the middle. Oyama (156) reports that different subjects use response distributions that differ in several different ways. The results of these papers were used in various ways to help interpret the judgment behavior of subjects.

RELATIONS AMONG DIFFERENT METHODS

There are three main types of responses that are used to derive scales: ratio judgments, category or rating judgments, and discriminations. Correspondingly, there are three basically different kinds of scales: magnitude scales, category scales, and discrimination scales, and over the years there have been a number of studies of the relations among them. Previously the consensus was probably that discrimination scales are logarithmically related to magnitude scales with category scales bearing an intermediate, quasi-log relation. The recent evidence, however, shows that a variety of relations can exist among them. While John (115) found the usual quasi-log relation between category ratings and magnitude estimates, Sjöberg (183) found linear relations among magnitude scales, successive intervals (discrimination), and numerical paired comparisons. However, in another study (182) he found a curvilinear relation between magnitude and successive intervals scales; the numerical paired comparison behaved like magnitude, but a Thurstonian analysis of the paired comparisons choices showed a curvilinear relation. Bruvold (27) found, in a case where discriminal dispersions were equal, that category and successive intervals scales were linearly related. Gregson et al (90) found that when two anchors were given for "ratio" judgments the scale apparently acted like a category scale. Markley et al (134) compared magnitude estimates and category ratings of *difference* in line length, finding a linear relation between the two. Curtis (46) also compared the two methods as applied to difference judgments, finding that the relation was linear in log-log coordinates. The relations are simple in any one study, but it will take considerable thought and probably additional data to sort out the principles which determine which kind of relation to expect in a given situation. Perhaps some of the conclusions from the next section, Psychophysical Relations, will shed light on the question.

PSYCHOPHYSICAL RELATIONS

The objective of science is to find order—order epitomized by various laws—and it is a source of frustration to some to find that after more than a century it is still not clear, at least to everyone, what the psychophysical law is, or if there is more than one, or even if there is any at all. The study of psychophysics typifies active scientific fields in that it provides considerable careful empirical research, inspires some deep theoretical formulation, and excites a good deal of emotion on the part of the participants.

Recent literature includes a number of papers challenging or supporting aspects of the power law relation between physical magnitude and judged magnitude. There were some very interesting developments in the study of the relation of reaction time to each. There were also several interesting studies in what might be called compound psychophysics, the relation between judgments of sums, differences, and the like, and the physical quantities involved. We may even be approaching some sort of integration and reconciliation of the principal generalizations and theories.

EVIDENCE REGARDING THE POWER LAW

One of the most remarkable and regular empirical relations in psychology is that which emerges when a subject is asked to judge ratios of simple physical quantities or intensities: the power law. This states that judged intensity ψ is a power function of physical or objective intensity ϕ: $\psi = k\phi^m$, where m is a parameter which is supposedly characteristic of a given continuum and k is an arbitrary constant depending on the units of the physical continuum and the modulus the judge is using. Examples of this relation are by now numerous enough, so we review here only the more controversial aspects of what has come to be called Stevens' law, attempts to provide a rationale for it, and interrelations among instances of it.

A problem posed for the power law is the apparent existence of individual differences in the exponents found for a given continuum. One interpretation of the variations in exponent is that it merely reflects some sort of habit or preference on the part of the judge concerning how to use the number scale, and if this rather than some difference in perceptual or sensory functioning is indeed the case, then exponents should correlate between modalities. Several studies (20, 61, 152, 199) found individual differences in exponents to be very wide and fairly consistent across continua and over time, although test-retest reliabilities decreased with time interval, and consistency was not universally found (cf Berglund et al 21). Rule & Markley (173) found, however, that correlations between exponents obtained for the same stimulus modality but different response procedures were near zero. Their conclusion, and one that is consistent with the other studies, is " . . . that variability of exponents stems more from idiosyncratic response biases than from differences in sensory characteristics." Together with the contemporary view that numerical judgment methods are just one form of cross-modality matching, this conclusion makes the individual differences in exponents a less serious problem for power-law psychophysics than at first appeared, but suggests that cross-modality matches should be at best only approximately consistent with exponents from ratio judgment procedures.

A basis for rejection of Fechner's law as a description of subjective magnitude is the frequently repeated assertion that equal log-steps of intensity at different stimulus levels do not sound equally different. Any assumption that equal differences on a ratio-judgment scale will sound equally different also needs empirical examination, however. Such a study was done by Beck & Shaw (19), who found that equal intervals on the sone scale (ratio judgment) were not judged equal, but equal intervals on the lambda (equi-section) scale were. Stevens (191, 195) replies to this and to a number of other papers which challenged aspects of the ratio methods and the power law. He argues that the effects found are results of such things as underestimates of slope due to statistical regression and special experimental problems with some modalities. He also suggests that in some cases a threshold must be solved for (cf Marks & Stevens 144) and failure to do this distorts the scale. However, it appears that an additive constant may also be necessary on the psychological scale, posing an additional conceptual difficulty. Stevens' (191) procedural suggestions for finding the "right" psychophysical relation have the effect of emphasizing the fragility of any particular value obtained as parameters of the relation, and therefore imply that various consistencies among judgments will only occur under special circumstances, a condition which greatly reduces the power of the power law. One cannot question the fact, however, that very neat psychophysical relations have been found with the ratio methods in many studies. There does appear to be a serious question now about just what the results mean.

Krantz (123) presents a formalization of the way in which such consistencies as independence from modulus stimulus and the power law lead to ratio scales, and presents a theory to account for the consistencies. The theory takes the concept of *stimulus relations* rather than sensation magnitudes as such as the central basis of judgment. It is interesting in many respects, but the rather doubtful empirical status of many of the consistencies which are used as its basis calls into question its ultimate value. In a somewhat different vein, Osborne (155) generalizes the restrictions imposed upon the nature of relations among scales by their respective scale properties.

Interestingly enough, the power law received support from electrophysiological measurements. Drake et al (54) found that such measurements made on frogs were linear in log-log coordinates with the concentration of an odorant. Franzen (73) found (in humans) that electrophysiological response to vibration to the finger was a power function of stimulus intensity. Stevens (194), for the most part reviewing old published data, reports that receptors respond to input energy by a power law in terms of frequency of spikes. He notes, however, that in some modalities, e.g. audition, the response of the end organ is a complex, even nonmonotonic function of the input energy, but feels that the complexities are ironed out at higher levels in the nervous system. The complexities of the mechanisms which the receptor systems employ, presumably so as to be able to handle wide ranges, are such as to make the existence of any simple psychophysical relations extremely surprising. It may also be noted that Eijkman et al (58) argue that a power-law transducer is necessary for a Weber's law effect.

RELATIONS BETWEEN DISCRIMINABILITY AND RATIO JUDGMENT SCALES

A number of developments support a reconciliation of the nature of the scales determined by ratio judgment methods with those determined by discrimination, mainly revolving around the fact that discriminability and subjective ratios must, on the evidence, be closely related. The basic reason rests on the two fundamental *empirical* generalizations of psychophysics: Weber's law and Stevens' empirical law that equal stimulus ratios are judged equal. It is fairly widely recognized (e.g. 12, 123, 198) that Weber's law can be restated as "Equal stimulus ratios are equally discriminable." Since equal stimulus ratios form equal subjective ratios, *equidiscriminable stimuli form equal subjective ratios.*

Teghtsoonian (198) collates data from several sources to form the basis of some interesting observations relevant to Fechner-Stevens relations. First, he takes the results of a number of ratio-judgment studies and tabulates the exponents (m) derived and the stimulus range used, finding that the two correlate .935. Then, for a number of continua he takes the Weber fraction $\Delta\phi/\phi$ and uses it, together with the exponent for that continuum, to solve for the *subjective* "Weber fraction" $\Delta\Psi/\Psi$, finding it to be virtually constant regardless of the modality. He concludes that there is a common (i.e. modality-free) sensory magnitude scale, and that the exponents obtained in ratio experiments are a function of the dynamic stimulus ranges being fitted into this one subjective scale. Assuming that the studies used to estimate the Weber fractions and Stevens exponents are representative, the conclusion seems reasonable.

A second provocative article in this area is one by Thijssen & Vendrik (200). Building on a suggestion of a "multi-range meter" model by Eijkman et al (58), they propose a mechanism which seems related to Teghtsoonian's proposal. They hypothesize that the judge sets a "gain factor" if he can and that when he is given this opportunity, as when only a narrow stimulus range is used, *Weber's law will not hold.* Using TSD methodology in a series of studies using narrow stimulus ranges, their data indicate that there is virtually no change in discriminability with change in stimulus level although the d' values for the different stimuli are quite different. One of their other findings is that the slope of the function relating *d'* to stimulus level (which would correspond to the exponent in a power law) changes with different stimulus ranges. Granted this is only one study of this kind (and the details of their methodology seem perhaps a little unorthodox, at least to a nonspecialist) their results are very intriguing, and the explanation offered is worth, examination.

Beck & Shaw (19) made an additional finding worth noting in this context. This was that magnitude estimates of the *differences* between stimuli were exponentially related to the number of jnds separating the two stimuli, a further indication of a relation between judgment and discriminability. Baird (13, 14) offers a cognitive theory of psychophysics similar in some respects to Poulton's (161), emphasizing the adaptational aspects of psychophysical judgments. Thus, with numerical judgments of either the category of ratio types the judge is attempting to maximize the amount of information contained in his judgments. This would appear to be consistent, at least qualitatively, with many of the observed effects of the stimulus set, of which Ross & Di Lollo's (171) is perhaps the most striking recent example.

There were several interesting papers on discriminability theory itself and upon the interrelations of discrimination and stimulus judgments with *reaction time*. Krantz (122) noted the circumstances under which the integration of jnds is legitimate. Falmagne (67) described the conditions necessary for the construction of an equidiscrimination (Fechner) scale and went on to point out earlier literature which indicated *equivalence* between discrimination and reaction time as bases for the construction of discrimination scales. Luce & Green (139, 140) proposed an inclusive model for integrating discrimination, recognition, reaction time, simple detection, and magnitude estimation (see also 91, 201). The prime need here now is for extensive, systematic data from several modalities which trace equidiscriminability, equiratios, and equireaction time contours for the same stimuli. When plotted with stimulus pairs as the coordinates, these curves should all be noncrossing lines radiating from the origin (cf Levine 133, 134). The interesting question is then whether similar (or related) transformations of the stimulus space can render all of these various sets of contours into straight lines through the same origin. This is an exciting possibility, since such a transformation would be a psychophysical law of a much more fundamental and aesthetically satisfying kind than those formulated to date.

COMPOUND PSYCHOPHYSICS

The demonstration of a network of functionally simple relations is the best evidence both of conceptual grasp of the important variables in an area and of technical competence at manipulating them. Consequently, the finding that numerical judgments of stimulus pairs, triples, etc were close and simple functions of the stimulus magnitude is strong evidence that there is "something there" in psychophysics, and the frequency with which the functions were of the power family reinforces its credibility, whereas the instances where some other sort of equally simple relation is found leads one to seek a broader theoretical context.

Several studies investigated the relation between difference judgments and the physical value, finding regular results. Several studies (19, 46, 49, 64) found relations which were consistent with various related power law models for the relation between judgment of stimulus difference and the individual stimuli. Markley et al (143), whose subjects judged *similarity* of line length, found an exponential relation between these judgments and log physical length. Reconciliation of this result with the others is complicated by the complementary relation of similarity and difference. Several studies (8, 10, 47, 49) examined the nature of the relation between physical scale values and judgments when the subject is asked to judge the "sum" of two stimuli. The typical finding is that the subject's response is a linear combination of the power transforms of the two component stimuli. Feldman & Baird (68) presented lights and sounds together and asked for judgments of the intensity of the joint sensation, finding that magnitude estimates of sensation were a power function of intensity with exponent the average of the exponents of the component stimuli.

Other compound stimulus studies include (21), which found that when two rather similar odorants were mixed, the intensity of the combinations were about .6 times the sum of the judged intensities of the components. In perhaps the most striking study of all, Franzen (73) found that not only did the power function hold with respect to both judgment and electrophysiological response for vibration transmitted to the finger, but when two and three fingers were stimulated simultaneously, the sensations increased with the square root of the number of fingers stimulated. These results, showing close relations usually involving a power law, further support the validity of the judgments obtained by psychophysical methods (or remarkable docility and capacity for mental arithmetic on the part of the judges).

PSYCHOPHYSICAL THEORY

A fully satisfactory theory of ratio-judgment psychophysics has not yet been formulated, but some basic facts which it must explain are apparent. There is the power law itself, together with cross-modality consistency, qualified by the sensitivity to distribution of stimuli being judged. Then there is the equivalence of Stevens' and Weber's laws, the relation of exponents to Weber constants, and the dependence of the constant upon the stimulus range (198). The sympathies of the reviewer lie more with the adaptive adjustment viewpoints of such theorists as Poulton (161), Baird (13), Teghtsoonian (198), and Warren (213) rather than those of theorists like Stevens and Krantz who take the magnitude judgment results more literally and downplay the failures of the power law to work in detail.

It does seem that there must be some sort of all-purpose central mechanism that can be used to compare stimuli, and it may well be that it is more useful to think of this as a mechanism that compares relations rather than one which compares sensations.The rate of neural pulses has been suggested (e.g. 139) as the basis for such a mechanism. The work of Eijkman (58) and of Thijssen & Vendrik (200), while in need of follow-up, is the basis for the speculation that the mechanism for the determination of stimulus relations is a two-stage tuning process which both selects a band (on the basis of immediate past experience) and tunes to a place within the band on the basis of the immediate stimulus. The basis for stimulus relation *judgments* is output about which band is in use and how far the stimuli are separated on it. *Responses* (which are one stage removed from judgments) are further modulated by the judge's assumptions about the relation between payoff and magnitude of error in his responses, and by constraints imposed by the response scale made available to him.

TEXTS AND OVERVIEWS

Two texts (42, 164) on mathematical psychology containing several chapters on scaling topics were published recently. Both books were quite well-received (e.g. Freedle 74). However, there is no book more recent than Torgerson's (202), which attempts to provide a complete coverage of scaling theory and methodology.

Several writers commented on the place of quantification in the social sciences and on the philosophical foundations underlying scaling. Krantz et al (126) consider these questions very thoughtfully, of course, and Green & Carmone's book on multidimensional scaling (78) includes a useful summary. There is also the excellent review by Zinnes (222). In addition, Stevens (192, 193) and Guttman (95) consider such questions as the place of statistics and numerical representations in psychological research and theory. Campbell (29) clarifies the nature and function of operational definitions in a way that is in harmony with current approaches to measurement. Cliff (36, 38) provides general overviews of scaling and measurement, and Krantz (125) does so with a visual perception orientation. Luce (138) reviews a number of examples of quantification and developments in measurement theory, espousing the view that psychophysics cannot be a measurement system comparable to physics because it lacks the tight interrelational structure of the latter. Among these writers, and also on the part of Tukey (204), there is the recurrent theme that it is multiple interrelations among variables that are the framework from which both theory and quantifications hang. Also, there is recognition of the importance of letting the quantitative and qualitative relations in the data, rather than assumptions about the nature of the variables, be the primary determiner of the theory used to describe the relations.

Gulliksen's paper (93) includes a historical overview of scaling and quantification, emphasizing the contributions of Thurstone and those who followed in his tradition. Ekman (59), in one of the last papers written before his recent death, criticized the reluctance of psychologists to quantify variables and provides several interesting examples in which quantification provided insight into substantive problems. Keats (119), on the other hand, feels that scaling, and mathematical psychology in general, has not addressed itself directly enough to the issues central to the domain of psychology.

EVALUATION AND PROSPECTUS

It has been observed that psychologists concerned with scaling fall largely into two categories: those who are concerned with the construction of exquisite mathematical structures (the axiomatizers), and those who are concerned with methods for wringing a numerical result from given data sets (the representationalists). Both camps need to be concerned that they not drift too far from each other, and ideally they should keep together by *both staying close* to the problems raised by the data and theory of psychology as a whole.

It seems to me that there should be no essential conflict between the two approaches. The axiomatists describe the relations that must be present in a set of data in order for it to be *possible* to represent it as a particular function (the model) of underlying variables with particular properties (the scales). The representationalists *assume* a given model underlying the data, and concern themselves with finding those particular values of the variables which fit "best" with a given set of data. I would agree that if the model is fitted willy-nilly without even examining the data relations themselves to see which kinds of violations have taken place, then the injustice is grave. However, an equal injustice may occur if we attempt to limit our study to data which exactly conform to a consistent axiom set.

It is undoubtedly desirable that procedures for examining the qualitative relations which are the foundations of measurement models be incorporated in computer programs for deriving scale values, but I would believe in going ahead with the fitting of the model whenever it seems that the data tend to conform to the axioms of transitivity or double cancellation, or whatever, tolerating a certain number of violations. The data are not the same as the phenomena which the scientist is trying to describe with his model; rather they are reflections of them which may be distorted either systematically or randomly.

The exciting part of the modern development of models based on weaker relations is that they offer hope of reducing the systematic distortions. What is needed now are scaling methods based on the axiomatic models which can be used to estimate the numerical representation if it is there in the phenomena behind the observations. In the case of both axiomatically and functionally based models, statistical inference mechanisms need to be incorporated into the computer programs for finding numerical representations, methods which indicate both the degree of fit of the model and some sort of probability statement which indicates the confidence to be placed in the model as one which underlies the observations.

On the part of psychological science as a whole there is a tendency to think that the measurement specialists, along with other mathematical psychologists, should be confined either to a monastery, where they are removed from the buffets of problems of everyday science, or to a ghetto, where they can't threaten anyone but each other. Currently, they potentially have enough to contribute to psychology as a whole that it would be an unfortunate loss if they accepted either of these exiles. Modern measurement theory shows that there is more to be learned from our data than can be gleaned from the fanciest analysis of variance, and it is hoped that the next reviewer of this field is able to describe numerous attacks on the means of learning it. The reviewer feels some optimism that the current pragmatic philosophical orientation toward defining scales, supported as it now is by conjoint measurement and the other theoretical developments, can serve as the basis for the integration of measurement into the main body of psychological experimentation and theorization.

LITERATURE CITED

1. Abrahamson I. G., Levitt, H. 1969. Statistical analysis of data from experiments in human signal detection. *J. Math. Psychol.* 6:391–417
2. Adams, K., Ulehla, Z. J. 1971. Detection theory and problems of psycho-social discrimination. *Sociological Methodology*. In press
3. Adams, E. W., Fagot, R. F., Robinson, R. E. 1970. On the empirical status of axioms in theories of fundamental measurement. *J. Math. Psychol.* 7:379–409
4. Aiken, L. S., Brown, D. R. 1969. Visual form perception: Congruence among spatial configurations. *Percept. Psychophys.* 5: 155–60
5. Ibid. A spatial analysis of the discriminability of forms in noise, 171–75
6. Anderson, A. B. 1970. Brief report: the effect of aggregation on nonmetric multidimensional scaling solutions. *Multivar. Behav. Res.* 5:369–73
7. Anderson, N. H. 1969. Comment on "An analysis of variance model for the assessment of configural cue utilization in clinical judgment." *Psychol. Bull.* 72:63–65
8. Anderson, N. H. 1970. Functional measurement and psychophysical judgment. *Psychol. Rev.* 77:153–70
9. Ibid 1971. Integration theory and attitude change. 78:171–206
10. Anderson, N. H., Jacobson, A. 1968. Further data on a weighted average model for judgment in a lifted weight task. *Percept. Psychophys.* 4:81–84
11. Arnold, J. B. 1971. A multidimensional scaling study of semantic distance. *J. Exp. Psychol.* 90: 349–72
12. Auerbach, C. 1971. Interdependence of Stevens' exponents and discriminability measures. *Psychol. Rev.* 78:556
13. Baird, J. C. 1970. A cognitive theory of psychophysics, information transmission, partitioning, and Weber's law. *Scand. J. Psychol.* 11:35–46
14. Ibid. A cognitive theory of psychophysics. II. Fechner's law and Stevens' law, 89–102
15. Bechtel, G. G. 1968. Folded and unfolded scaling from preferential paired comparisons. *J. Math. Psychol.* 5:333–57
16. Bechtel, G. G. 1971. A covariance analysis of multiple paired comparisons. *Psychometrika* 36:35–55
17. Ibid. A dual scaling analysis for paired comparisons, 135–54
18. Bechtel, G. G., Tucker, R., Chang, W. 1971. A scalar product model for the multidimensional scaling of choice. *Psychometrika* 36:369–88
19. Beck, J., Shaw, W. A. 1967. Ratio-estimation of loudness-intervals. *Am. J. Psychol.* 80:59–65
20. Berglund, B., Berglund, U., Ekman, G., Engen, T. 1971. Individual psychophysical functions for 28 odorants. *Percept. Psychophys.* 9: 379–84
21. Berglund, B., Berglund, U., Lindvall, T. 1971. On the principle of odor interaction. *Acta Psychol.* 35: 255–68
22. Bock, R. D. 1970. Estimating multinomial response relations. In *Essays in Probability and Statistics*, ed. R. C. Bose, I. M. Chakeravarti, P. C. Mahalanobis, C. R. Rao, K. J. C. Smith, 111–32. Chapel Hill, N. C.: Univ. North Carolina Press. 770 pp.
23. Bogartz, R. S., Wackwitz, J. H. 1971. Polynomial response scaling and functional measurement. *J. Math. Psychol.* 8:418–43
24. Bricker, P. D. 1971. Listener evaluation of simulated telephone calling signals. *Bell Syst. Tech. J.* 50: 1559–78
25. Brown, D. R., Andrews, M. H. 1968. Visual form discrimination: Multidimensional analyses. *Percept. Psychophys.* 3:401–6
26. Brown, D. R., Brumaghim, S. H. 1968. Perceptual equivalence, pattern perception and multidimensional methods. *Percept. Psychophys.* 4:253–56
27. Bruvold, W. H. 1969. Category and successive intervals scales for rating statements and stimulus objects. *J. Exp. Psychol.* 81:230–34
28. Burke, C. J. 1970. Density and length. *J. Math. Psychol.* 7:466–77
29. Campbell, D. T. 1969. Definitional versus multiple operationism. *Et Al* 2:14–17
30. Carroll, J. D. 1968. Generalization of canonical correlation analysis to

three or more sets of variables. *Proc. 76th Ann. Conv. APA* 3: 227–28

31. Carroll, J. D., Chang, J. J. 1970. Analysis of individual differences in multidimensional scaling via an n-way generalization of "Eckhart-Young" decomposition. *Psychometrika* 35:283–319
32. Carroll, J. D., Chang, J. J. 1970. Reanalysis of some color data of Helm's by indscal procedure for individual differences multidimensional scaling. *Proc. 78th Ann. Conv. APA* 5:137–38
33. Cliff, N. 1968. Adjective check list responses and individual differences in perceived meaning. *Educ. Psychol. Meas.* 28:1063–77
34. Cliff, N. 1972. Consistencies among judgments of adjective confirmations. In *Multidimensional Scaling, Vol. II, Applications*, ed. A. K. Romney, R. N. Shepard, S. B. Nerlove, 163–82. New York: Seminar Press. 467 pp.
35. Cliff, N. 1969. Liking judgments and multidimensional scaling. *Educ. Psychol. Meas.* 29:73–86
36. Cliff, N. 1972. Psychometrics. In *Handbook of Psychology*, ed. B. B. Wolman, 1084–99. New York: Prentice-Hall. 1488 pp.
37. Cliff, N. 1968. The "idealized individual" interpretation of individual differences in multidimensional scaling. *Psychometrika* 33: 225–32
38. Cliff, N. 1969. Scaling. In *Encyclopedia of Educational Research*, ed. R. L. Ebel, V. H. Noll, 1166–74. Toronto: Macmillan. 1522 pp.
39. Cliff, N., Young, F. W. 1968. On the relation between unidimensional judgments and multidimensional scaling. *Organ. Behav. Hum. Perform.* 3:269–85
40. Coles, G. J., Stone, L. A. 1972. A new methodological revision of Ekman's "content" model of multidimensional similarity analysis. *Multivar. Behav. Res.* 7:85–107
41. Coombs, C. H. 1964. *A Theory of Data*. New York: Wiley. 585 pp.
42. Coombs, C. H., Dawes, R. M., Tversky, A. 1970. *Mathematical Psychology, an Elementary Introduction*. Englewood Cliffs, N. J.: Prentice-Hall. 419 pp.
43. Coombs, C. H., Huang, L. C. 1970. Polynomial psychophysics of risk. *J. Math. Psychol.* 7:317–38
44. Cooper, L. G. 1972. A new solution to the additive constant problem in metric multidimensional scaling. *Psychometrika*. In press
45. Corso, J. F. 1971. Adaptation-level theory and psychophysical scaling. *Adaptation-level Theory: A Symposium*, ed. M. H. Appley, 27–47. New York: Academic. 338 pp.
46. Curtis, D. W. 1970. Magnitude estimations and category judgments of brightness and brightness intervals. *J. Exp. Psychol.* 83:201–8
47. Curtis, D. W., Fox, B. E. 1969. Direct quantitative judgments of sums and a two-stage model for psychological judgments. *Percept. Psychophys.* 5:89–93
48. Dansereau, D. F., Fenker, R. M., Evans, S. H. 1970. Visual pattern perception: encoding and storage of schematic versus random patterns. *Proc. 78th Ann. Conv. APA* 49–50
49. Dawson, W. E. 1971. Magnitude estimation of apparent sums and differences. *Percept. Psychophys.* 9:368–74
50. Degerman, R. 1970. Multidimensional analysis of complex structure: mixtures of class and quantitative variation. *Psychometrika* 35:475–91
51. Delbeke, L. 1968. *Construction of Preference Spaces*. Louvain-Leuven, Belgium: Univ. Louvain. 180 pp.
52. Domotor, Z., Stelzer, J. 1971. Representation of finitely additive semiordered qualitative probability structures. *J. Math. Psychol.* 8: 145–58
53. Dorfman, D. D., Alf, E. Jr. 1969. Maximum likelihood estimation of parameters of signal detection theory and determination of confidence intervals: Rating-method data. *J. Math. Psychol.* 6:487–96
54. Drake, B., Johansson, B., von Sydow, E., Doving, K. B. 1969. Quantitative psychophysical and electrophysical data on some odorous compounds. *Scand. J. Psychol.* 10:89–96
55. Ducamp, A., Falmagne, J. C. 1969. Composite measurement. *J. Math. Psychol.* 6:359–90
56. Dunn-Rankin, P., King, F. J. 1969. Multiple comparisons in a simpli-

fied rank method of scaling. *Educ. Psychol. Meas.* 29:315–29

57. Egeth, H., Avant, L. L., Bevan, W. 1968. Does context influence the shape of a perceptual scale? *Percept. Psychophys.* 4:54–56
58. Eijkman, E., Thijssen, J. M., Vendrik, A. J. H. 1966. Weber's law, power law, and internal noise. *J. Acoust. Soc. Am.* 40:1164–73
59. Ekman, G. 1970. Quantitative approaches to psychological problems. In *Theory and Methods in Behavioural Sciences*, ed. P. Lindblon. Stockholm: Laromedelsforlaget. 154 pp.
60. Ekman, G. 1970. Comparative studies in multidimensional scaling and related techniques. In *Perspectives in Multivariate Psychological Research*, ed. K. Pawlik. Bern: Huber. 421 pp.
61. Ekman, G., Hosman, B., Lindman, R., Ljungberg, L., Akesson, C. A. 1968. Inter-individual differences in scaling performance. *Percept. Mot. Skills* 26:815–23
62. Ekman, G., Kuennapas, T. 1969. Distribution function for similarity estimates. *Percept. Mot. Skills* 29:967–83
63. Eyman, R. K., Kim, P. J. 1970. A model for partitioning judgment error in psychophysics. *Psychol. Bull.* 74:35–46
64. Fagot, R. F., Stewart, M. R. 1969. Tests of product and additive scaling axioms. *Percept. Psychophys.* 5:117–23
65. Ibid 1970. Test of a response bias model of bisection. 7:257–62
66. Falmagne, J. C. 1971. Bounded versions of Holder's theorem with application to extensive measurement. *J. Math. Psychol.* 8:495–507
67. Ibid. The generalized Fechner problem and discrimination, 22–43
68. Feldman, J., Baird, J. C. 1971. Magnitude estimates of multidimensional stimuli. *Percept. Psychophys.* 10:418–21
69. Fenker, R. M. Jr., Brown, D. R. 1969. Pattern perception, conceptual spaces, and dimensional limitations on information processing. *Multivar. Behav. Res.* 4: 257–73
70. Fishburn, P. C. 1968. Semiorders and risky choices. *J. Math. Psychol.* 5:358–61
71. Ibid 1970. Intransitive indifference with unequal intervals. 7:144–49
72. Ibid 1971. Additive representations of real-valued functions on subsets of product sets. 8:382–88
73. Franzen, O. 1969. On spatial summation in the tactual sense. A psychophysical and neurophysiological study. *Scand. J. Psychol.* 10:193–208
74. Freedle, R. 1971. Reviews of Refs. 42 and 164. *Psychometrika* 36: 322–28
75. Freedle, R., Lewis, M. 1970. On relating an infant's observation time of visual stimuli with Choice-Theory analysis. *Develop. Psychol.* 2:129–30
76. Friendly, M. L., Glucksberg, S. 1970. On the description of subcultural lexicons: a multidimensional approach. *J. Pers. Soc. Psychol.* 14:55–65
77. Garner, W. R., Felfoldy, G. L. 1970. Integrality of stimulus dimensions in various types of information processing. *Cogn. Psychol.* 1: 225–41
78. Green, P. E., Carmone, F. J. 1970. *Multidimensional Scaling and Related Techniques in Marketing Analysis.* Boston: Allyn and Bacon. 203 pp.
79. Green, P. E., Carmone, F. J. 1971. The effect of task on intraindividual differences in similarities judgments. *Multivar. Behav. Res.* 6:433–50
80. Green, P. E., Carmone, F. J., Fox, L. B. 1969. Television programme similarities: an application of subjective clustering. *J. Market. Res. Soc.* 11:70–90
81. Green, P. E., Maheshwari, A. 1970. A note on the multidimensional scaling of conditional proximity data. *J. Market. Res.* 7:106–10
82. Green, P. E., Maheshwari, A., Rao, V. R. 1969. Dimensional integration and configural invariance in multidimensional scaling. *Multivar. Behav. Res.* 4:159–80
83. Green, P. E., Maheshwari, A., Rao, V. R. 1969. Self-concept and brand preference: an empirical application of multidimensional scaling. *J. Market. Res. Soc.* 11:343–60
84. Green, P. E., Rao, V. R. 1969. A Note on proximity measures and cluster analysis. *J. Market. Res.* 6: 359–64
85. Green, P. E., Rao, V. R. 1970. Rating scales and information recovery—how many scales and

response categories to use? *J. Market.* 34:33–40

86. Green, P. E., Rao, V. R., Vallieres, R. 1970. A note on the Spaeth-Guthery multidimensional scaling analysis of synthetic data (mimeo)
87. Gregson, R. A. M. 1968. Simulating perceived similarities between taste mixtures having mutually interacting components. *Brit. J. Math. Statist. Psychol.* 21:117–30
88. Gregson, R. A. M. 1969. A comparison of two models representing taste mixture similarities in a cross-modal matching task. *Multivar. Behav. Res.* 4:147–59
89. Gregson, R. A. M. 1970. Quadratic similarity. *Brit. J. Math. Statist. Psychol.* 23:53–68
90. Gregson, R. A. M., Mitchell, M. J., Simmonds, M. B., Wells, J. E. 1969. Relative olfactory intensity perception as mediated by ratio-range category scale responses. *Percept. Psychophys.* 6:133–38
91. Grice, G. R. 1968. Stimulus intensity and response evocation. *Psychol. Rev.* 75:359–73
92. Gulliksen, H. 1959. Mathematical solutions for psychological problems. *Am. Sci.* 47:178–201
93. Gulliksen, H. 1968. Louis Leon Thurstone, experimental and mathematical psychologist. *Am. Psychol.* 23:786–802
94. Guttman, L. 1968. A general nonmetric technique for finding the smallest coordinate space for a configuration of points. *Psychometrika* 33:469–506
95. Ibid 1971. Measurement as structural theory. 36:329–48
96. Hall, R. F. 1970. An application of unfolding theory to the measurement of attitudes. *Educ. Psychol. Meas.* 30:621–37
97. Hall, R. F. 1971. Laterality effects in the method of triads. *Percept. Psychophys.* 10:101–4
98. Heise, D. R. 1969. Some methodological issues in semantic differential research. *Psychol. Bull.* 72:406–22
99. Helson, H., Kozaki, A. 1968. Anchor effects using numerical estimates of simple dot patterns. *Percept. Psychophys.* 4:163–64
100. Henley, N. M. 1969. A psychological study of the semantics of animal terms. *J. Verb. Learn. Verb. Behav.* 8:176–84
101. Herrick, R. M. 1969. Psychophysical methodology: comparisons within the method of limits. *Percept. Mot. Skills* 28:503–14
102. Herrick, R. M. 1970. Psychophysical methodology IV; Phi gamma hypothesis and the method of limits. *Percept. Psychophys.* 8:61–64
103. Ibid. Psychophysical methodology: Deductions from the phi-gamma hypothesis and related hypotheses. 7:73–78
104. Hofstee, W. K. 1970. Comparative vs. absolute judgments of trait desirability. *Educ. Psychol. Meas.* 30:639–46
105. Holman, E. W. 1969. Strong and weak extensive measurement. *J. Math. Psychol.* 6:286–93
106. Ibid 1971. A note on additive conjoint measurement. 8:489–94
107. Horan, C. B. 1969. Multidimensional scaling: combining observations when individuals have different perceptual structures. *Psychometrika* 34:139–65
108. Hyman, R., Well, A. 1967. Judgments of similarity and spatial models. *Percept. Psychophys.* 2:233–48
109. Ibid 1968. Perceptual separability and spatial models. 3:161–65
110. Indow, T. 1969. An application of the t (tau) scale of taste: interaction among the four qualities of taste. *Percept. Psychophys.* 5:347–51
111. Indow, T. 1970. Formation of subjective value: A theoretical and empirical analysis: I. *Jap. Psychol. Res.* 12:184–91
112. Ibid 1971. Formation of subjective value: A theoretical and empirical analysis: II. 13:1–10
113. Indow, T., Matsushima, K. 1969. Local multidimensional mapping of Munsell color space. *Acta Chromatica* 2:16–24
114. Isaac, P. D. 1970. Dissimilarities as indices of individual perceptual structure. *Percept. Psychophys.* 7:229–34
115. John, I. D. 1969. Stimulus discriminability in the magnitude estimation and category rating of loudness. *Percept. Psychophys.* 6:78
116. John, I. D. 1971. The properties of distributions of magnitude estimates of loudness and softness. *Scand. J. Psychol.* 12:261–70
117. Johnson, D. M., Mullally, C. R. 1969. Correlation-and-regression

model for category judgments. *Psychol. Rev.* 76:205–15

118. Johnson, P. E., Cox, D. L., Curron, T. E. 1970. Psychological reality of physical concepts. *Psychon. Sci.* 19:245–47
119. Keats, J. A. 1970. The gap between theory and data. *Aust. Psychol.* 5:221–36
120. Klahr, D. 1969. A Monte Carlo investigation of the statistical significance of Kruskal's nonmetric scaling procedure. *Psychometrika* 34:319–30
121. Krantz, D. 1968. A theory of context effects based on cross-context matching. *J. Math. Psychol.* 5: 1–48
122. Krantz, D. H. 1971. Integration of just-noticeable differences. *J. Math. Psychol.* 8:591–99
123. Ibid 1972. A theory of magnitude estimation and cross-modality matching. In press
124. Krantz, D. H. 1972. Measurement structures and psychological laws. *Science* 175:1427–35
125. Krantz, D. H. 1972. Visual scaling. *Handbook of Sensory Physiology*, ed. D. J. Hurvich, L. M. Hurvich, 7(4):1–29. Heidelberg: Springer-Verlag. 497 pp.
126. Krantz, D. H., Luce, R. D., Suppes, P., Tversky, A. 1971. *Foundations of measurement*, Vol. 1. Additive and Polynomial Representations. New York: Academic. 597 pp.
127. Krantz, D. H., Tversky, A. 1971. Conjoint-measurement analysis of composition rules in psychology. *Psychol. Rev.* 78:151–69
128. Ibid. Untitled, 457–58
129. Kristof, W. 1968. Structural properties and measurement theory of certain sets admitting a concatenation operation. *Brit. J. Math. Statist. Psychol.* 21:201–29
130. Kruskal, J. B. 1971. Monotone regression: contiguity and differentiability properties. *Psychometrika* 36:57–61
131. Kruskal, J. B., Carroll, J. D. 1969. Geometrical models and badness-of-fit functions. In *Multivariate Analysis*, ed. P. R. Krishiah, 2: 639–71. New York: Academic. 696 pp.
132. Lee, W. 1969. Relationships between Thurstone category scaling and signal detection theory. *Psychol. Bull.* 71:101–7
133. Levine, M. V. 1970. Transformations that render curves parallel. *J. Math. Psychol.* 7:410–43
134. Ibid 1972. Transforming curves into curves with the same shape. 9:1–16
135. Lingoes, J. C. 1972. A Fortran IV (G) program for Guttman-Lingoes conjoint measurement—V. *Behav. Sci.* 17:333–34
136. Lingoes, J. C. 1971. Some boundary conditions for a monotone analysis of symmetric matrices. *Psychometrika* 36:195–203
137. Lingoes, J. C. 1968. The rationale of the Guttman-Lingoes nonmetric series: a letter to Doctor Philip Runkel. *Multivar. Behav. Res.* 3:495–507
138. Luce, R. D. 1972. What sort of measurement is psychophysical measurement? *Am. Psychol.* 27: 96–106
139. Luce, R. D., Green, D. M. 1972. A neural timing theory for response times and the psychophysics of intensity. *Psychol. Rev.* 79:14–57
140. Luce, R. D., Green, D. M. 1970. Detection of auditory signals presented at random times. II. *Percept. Psychophys.* 7:1–14
141. Luce, R. D., Tukey, J. W. 1964. Simultaneous conjoint measurement: A new type of fundamental measurement. *J. Math. Psychol.* 1:1–27
142. Lund, T. 1970. Multidimensional scaling of geometrical figures. *Scand. J. Psychol.* 11:246–54
143. Markley, R. P., Ayers, D., Rule, S. J. 1969. Similarity judgments of line length. *Percept. Psychophys.* 6: 58–60
144. Marks, L. E., Stevens, J. C. 1968. The form of the psychophysical function near threshold. *Percept. Psychophys.* 4:315–18
145. Marley, A. A. J. 1968. Some probabilistic models of simple choice and ranking. *J. Math. Psychol.* 5: 311–32
146. Ibid 1971. Conditions for the representation of absolute judgment and pair comparison isosensitivity curves by cumulative distributions. 8:554–90
147. Maruyama, K. 1969. On the minimum dimension analysis (I)—new approach by quantification theory. *Jap. Psychol. Res.* 11:134–46
148. McGee, V. E. 1968. Multidimensional scaling of N sets of similarity measures: a nonmetric in-

dividual differences approach. *Multivar. Behav. Res.* 3:233–48

149. Micko, H. C. 1970. A "halo" model for multidimensional ratio scaling. *Psychometrika* 35:199–227
150. Micko, H. C., Fischer, W. 1970. The metric of multidimensional psychological spaces as a function of the differential attention to subjective attributes. *J. Math. Psychol.* 7:118–43
151. Micko, H. C., Lehman, G. 1969. Two least-squares solutions for Ekman's method of direct multidimensional ratio scaling. *Scand. J. Psychol.* 10:57–60
152. Mitchell, M. J., Gregson, R. A. M. 1971. Between-subject variation and within-subject consistency of olfactory intensity scaling. *J. Exp. Psychol.* 89:314–18
153. Nordenstreng, K. 1968. A comparison between the semantic differential and similarity analysis in the measurement of musical experience. *Scand. J. Psychol.* 9:89–96
154. Ogilvie, J. C., Creelman, C. D. 1968. Maximum likelihood estimation of receiver operating characteristic curve parameters. *J. Math. Psychol.* 5:377–91
155. Osborne, D. K. 1970. Further extensions of a theorem of dimensional analysis. *J. Math. Psychol.* 7:236–42
156. Oyama, T. 1968. A behavioristic analysis of Stevens' magnitude estimation method. *Percept. Psychophys.* 3:317–20
157. Parducci, A., Perrett, L. F. 1971. Category rating scales: effects of relative spacing and frequency of stimulus values. *J. Exp. Psychol.* 89:427–52
158. Pfanzagl, J. 1968. *Theory of measurement.* New York: Wiley. 235 pp.
159. Phillips, J. P. N. 1971. A note on the representation of ordered metric scaling. *Brit. J. Math. Statist. Psychol.* 24:239–50
160. Pollack, I. 1968. Methodological examination of the PEST (Parametric Estimation by Sequential Testing) procedure. *Percept. Psychophys.* 3:285–89
161. Poulton, E. C. 1968. The new psychophysics: six models for magnitude estimation. *Psychol. Bull.* 69:1–19
162. Ramsay, J. O. 1969. Some statistical considerations in multidimensional scaling. *Psychometrika* 34:167–82
163. Rankin, W. C., Markley, R. P., Evans, S. H. 1970. Pythagorean distance and the judged similarity of schematic stimuli. *Percept. Psychophys.* 7:103–8
164. Restle, F., Greeno, J. G. 1970. *Introduction to Mathematical Psychology.* Reading, Mass.: Addison-Wesley. 371 pp.
165. Richards, B. L., Thornton, C. L. 1970. Quantitative methods of calculating the *d'* of signal detection theory. *Educ. Psychol. Meas.* 30:855–59
166. Roberts, F. S. 1970. On nontransitive indifference. *J. Math. Psychol.* 7:243–58
167. Ibid 1971. Homogeneous families of semiorders and the theory of probabilistic consistency. 8:248–63
168. Roberts, F. S., Luce, R. D. 1968. Axiomatic thermodynamics and extensive measurement. *Synthese* 18:311–26
169. Rosenberg, S., Nelson, C., Vivekananthan, P. S. 1968. A multidimensional approach to the structure of personality impressions. *J. Pers. Soc. Psychol.* 9:283–94
170. Roskam, E. E. 1970. The method of triads for nonmetric multidimensional scaling. *Neth. J. Psychol.* 25:404–17
171. Ross, J., Di Lollo, V. 1971. Judgment and response in magnitude estimation. *Psychol. Rev.* 78:515–27
172. Rule, S. J. 1969. Average exponent from magnitude production. *Psychometrika* 34:233–35
173. Rule, S. J., Markley, R. P. 1971. Subject differences in cross-modality matching. *Percept. Psychophys.* 9:115–17
174. Rumelhart, D. E., Greeno, J. G. 1971. Similarity between stimuli: and experimental test of the Luce and Restle choice of models. *J. Math. Psychol.* 8:370–81
175. Schonemann, P. H. 1970. A note on Gulliksen's least squares solution for incomplete data. *Brit. J. Math. Statist. Psychol.* 23:69–71
176. Schonemann, P. H. 1970. On metric multidimensional unfolding. *Psychometrika* 35:349–66
177. Schonemann, P. H., Carroll, R. M. 1970. Fitting one matrix to another under choice of a central dilation and a rigid motion. *Psychometrika* 35:245–55

178. Shanteau, J. C., Anderson, N. H. 1969. Test of a conflict model for preference judgment. *J. Math. Psychol.* 6:312–25

179. Shepard, R. N. 1962. The analysis of proximities: Multidimensional scaling with an unknown distance function. I. *Psychometrika* 27:125–40

180. Shepard, R. N., Chipman, S. 1970. Second-order isomorphism of internalized representations: shapes of states. *Cogn. Psychol.* 1:1–17

181. Sherman, R. C. 1972. Individual differences in perceived trait relationships as a function of dimensional salience. *Multivar. Behav. Res.* 7:109–29

182. Sjöberg, L. 1968. Unidimensional scaling of multidimensional facial expressions. *J. Exp. Psychol.* 78:429–35

183. Sjöberg, L. 1968. The dimensionality paradox in comparative judgment: a resolution. *Scand. J. Psychol.* 9:97–108

184. Ibid. Studies of the rated favorableness of offers to gamble, 257–73

185. Ibid 1969. Sensation scales in the size-weight illusion. 10:109–12

186. Ibid 1971. Three models for the analysis of subjective ratios. 12:217–40

187. Slak, S. 1969. Multidimensional information transmission as a function of unidimensional channel capacity. *Psychol. Rev.* 76:224–26

188. Spaeth, H. J., Guthery, S. B. 1969. The use and utility of the monotone criterion in multidimensional scaling. *Multivar. Behav. Res.* 4:501–15

189. Steinheiser, F. H. 1970. Individual preference scales within a multidimensional "similarities" space. *J. Exp. Psychol.* 86:325–27

190. Stenson, H., Knoll, R. 1969. Goodness of fit for random rankings in Kruskal's nonmetric scaling procedures. *Psychol. Bull.* 71:122–26

191. Stevens, S. S. 1971. Issues in psychological measurement. *Psychol. Rev.* 78:426–50

192. Stevens, S. S. 1969. Measurement and social science. *Et Al* 2:5–6

193. Stevens, S. S. 1968. Measurement, statistics, and the schemapiric view. *Science* 161:849–56

194. Ibid 1970. Neural events and the psychophysical law. 170:1043–50

195. Stevens, S. S. 1969. On predicting exponents for cross-modality matches. *Percept. Psychophys.* 6:251–56

196. Stevens, S. S. 1957. On the psychophysical law. *Psychol. Rev.* 64:153–81

197. Svenson, O. 1970. A functional measurement approach to intuitive estimation as exemplified by estimated time savings. *J. Exp. Psychol.* 86:204–10

198. Teghtsoonian, R. 1971. On the exponents in Stevens' law and the constant in Ekman's law. *Psychol. Rev.* 78:71–80

199. Teghtsoonian, M., Teghtsoonian, R. 1971. How repeatable are Stevens' power law exponents for individual subjects? *Percept. Psychophys.* 10:147–49

200. Thijssen, J. M., Vendrik, A. J. H. 1968. Internal noise and transducer function in sensory detection experiments: evaluation of psychometric curves and of ROC curves. *Percept. Psychophys.* 3:387–400

201. Thomas, E. A. C. 1971. Sufficient conditions for monotone hazard rate: an application to latency-probability curves. *J. Math. Psychol.* 8:303–32

202. Torgerson, W. S. 1958. *Theory and Methods of Scaling.* New York: Wiley. 460 pp.

203. Tucker, L. R. 1966. Some mathematical notes on three-mode factor analysis. *Psychometrika* 31:279–311

204. Tukey, J. W. 1969. Analyzing data: sanctification or detective work? *Am. Psychol.* 24:83–91

205. Turner, R. E. 1971. Market measures from salesmen: a multidimensional scaling approach. *J. Market. Res.* 8:165–72

206. Tversky, A. 1969. Intransitivity of preferences. *Psychol. Rev.* 76:31–48

207. Tversky, A., Krantz, D. H. 1969. Similarity of schematic faces: a test of interdimensional additivity. *Percept. Psychophys.* 5:124–28

208. Tversky, A., Krantz, D. H. 1970. The dimensional representation and the metric structure of similarity data. *J. Math. Psychol.* 7:572–96

209. Tversky, A., Russo, J. E. 1969. Substitutability and similarity in binary choices. *J. Math. Psychol.* 6:1–12

210. Ulehla, Z. J., Martin, R. F. 1972. Operating characteristic analysis

of attribute ratings. *Behav. Res. Methods Instrum.* In press

211. Wagenaar, W. A., Padmos, P. 1971. Quantitative interpretation of stress in Kruskal's multidimensional scaling technique. *Brit. J. Math. Statist. Psychol.* 24:101–10
212. Wallsten, T. S. 1971. Subjective expected utility theory and subjects' probability estimates: use of measurement-free techniques. *J. Exp. Psychol.* 88:31–40
213. Warren, R. M. 1969. Visual intensity judgments: an empirical rule and a theory. *Psychol. Rev.* 76:16–30
214. Wender, K. 1971. A test of independence of dimensions in multidimensional scaling *Percept. Psychophys.* 10:30–32
215. Wickelgren, W. A. 1968. Unidimensional strength theory and component analysis of noise in absolute and comparative judgments. *J. Math. Psychol.* 5:102–22
216. Wish, M. 1970. Comparisons among multidimensional structures of nations based on difference measures of subjective similarity. *Gen. Syst.* 15:55–65
217. Wish, M., Deutsch, M., Biener, L. 1970. Differences in conceptual structures of nations: an exploratory study. *J. Pers. Soc. Psychol.* 3:361–73
218. Yoshida, M. 1968. Dimensions of tactual impressions (2). *Jap. Psychol. Res.* 10:157–73
219. Yoshida, M., Kimase, R., Kurokawa, J., Yashiro, A. 1970. Multidimensional scaling of emotion. *Jap. Psychol. Res.* 12:45–61
220. Young, F. W. 1970. Nonmetric multidimensional scaling: recovery of metric information. *Psychometrika* 35:455–73
221. Young, F. W. 1970. Nonmetric scaling of line lengths using latencies, similarity, and same-different judgments. *Percept. Psychophys.* 8:363–69
222. Zinnes, J. L. 1969. Scaling. *Ann. Rev. Psychol.* 20:447–78

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